

Strategies for Managing Citrus Decline in Nepal

Umesh Kumar Acharya^{1*} and Debraj Adhikari²

¹National Citrus Research Program, Paripatle, Dhankuta

²Plant Quarantine and Pesticide Management Centre, Lalitpur

*Corresponding author's Email: umeshach@gmail.com

*Orcid ID: 0000-0001-9197-5010

Abstract

Citrus is cultivated in Nepal from time immemorial. To increase the production and productivity Nepal has established two governmental farms at Malepatan, Pokhara and Paripatle, Dhankuta in 1960s. Later one more farm with focus on citrus fruit development has been established at Palpa. However, commercial cultivation has not picked up due to many abiotic and biotic factors among them citrus greening disease is devastating one. There are reports of every citrus cultivating districts has been reported infected with this malady but the extent could be different. There is no single shot technology to manage this disease. Integrated management technology applied in other part of the world could be applied in Nepali context too. First of all use of healthy sapling, vector control, and removal of infected trees and quarantine system while transporting citrus sapling within district, province and country should be strictly followed.

Keywords: Asian Citrus Psylla, Citrus decline, Citrus greening, Quarantine system

Introduction

Citrus is an important agriculture sub-sector for farmers in the mid hills and terai plains of Nepal. Citrus shares nearly 27.27% (46,715 ha) of the total area among the fruit area in Nepal. This indicates that citrus is the major fruit in Nepal, having significant place in the socioeconomic well-being of the Nepalese farmers (MoALD, 2021). Further, this is a high-value product with strong demand in domestic and international markets. However, the citrus production is not sufficient and satisfactory to meet the demand of the country (Dahal et al., 2020). The productive orchard size has been declined from 69.56% to 58.52% in last 12 years period (MoALD, 2021). Some studies revealed that such productivity deteriorated situation is mostly linked to poor orchard management and declining soil fertility

in Nepal. Citrus decline has been a major challenge for citrus growers in Nepal (Poudel et al., 2022). Citrus decline is a multi-faceted issue including biotic (diseases and insect pests) and abiotic (soil, water, and nutrition) components. Although the citrus decline has been spread throughout Nepal, it is reported to be severe in the Western Development Region (NARDF, 2010). Some citrus orchards are declined by the foot/root rot or gummosis disease caused by *Phytophthora* species (Poudel & Shrestha, 1995). Several insect pests induce decline e.g. Citrus psylla, fruit fly, scale insects, bugs, stem borer, and leaf miner (Budathoki & Pradhanang, 1990; Nath & Sikha, 2019) are responsible productivity decline of orchard. Additionally, the Chinese Citrus Flies (*Bactocera minax*), is the most dangerous pest and causes extensive

damage to citrus orchard leading to decline of yield (Sharma et al., 2015). Thus, there has been a huge scope of increasing the production and productivity through the use of improved technologies.

Methodology

This paper is based on literature survey and personal experience of the authors. Effort was made to assess the citrus decline; major cause and management focusing citrus greening disease by searching national and international journals, conferences, reports, newsletters, and books for information.

Discussion

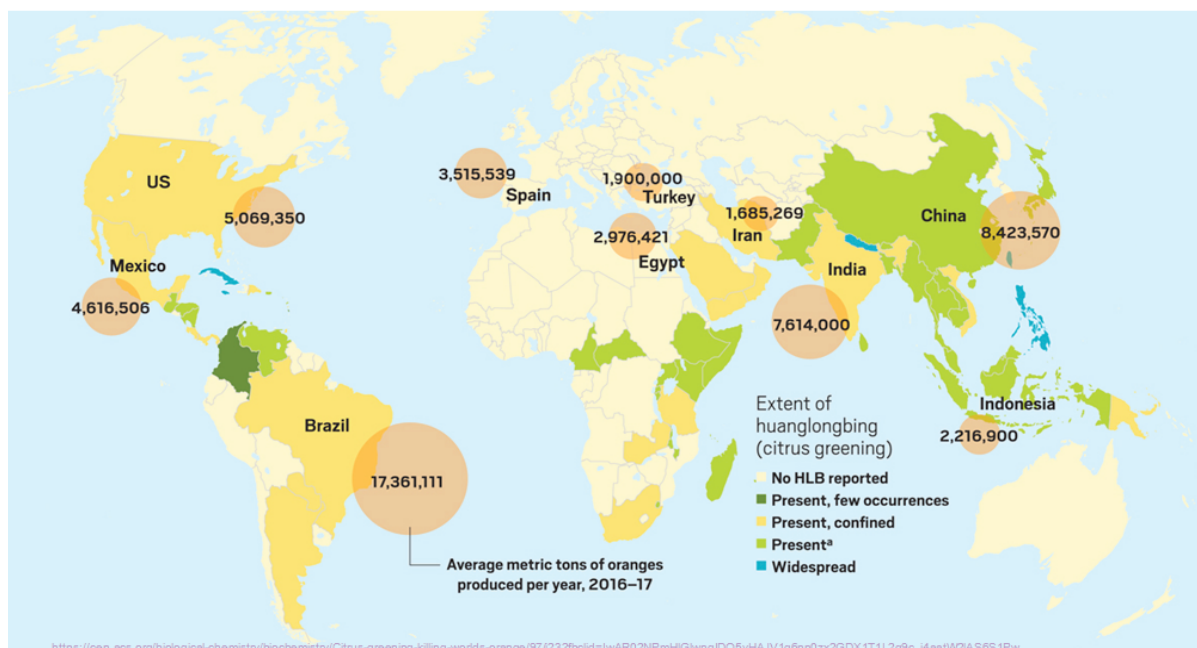
Citrus Decline

Citrus decline is a condition that exhibits various problems in the plant, resulting in decreased productivity, shorter productive life, and poor fruit quality (Panth & Dhakal, 2019; FAO, 2011; Poudel and Shrestha, 1995). According to a survey, 72.3 percent of mandarin-growing farmers in Magdi district experienced citrus decline problems in their orchards (Poudel et al., 2022). Citrus decline was shown to be influenced by disease and pest incidence, climate extremes, poor soil fertility, low quality planting materials, and poor orchard management practices. Citrus decline has been a serious and current constraint on citrus production in Nepal. It appears on productive trees between the ages of 15-20 years (FAO, 2011a). FAO (2011b) reported that use of substandard and uncertified seedlings, poor and or improper orchard management practice, nutritional problem, extensive intercropping with exhausting crops, incidence of greening and other diseases such as phytophthora, CTV, canker, powdery mildew; incidence of insect-pests like fruit fly, citrus psylla, scale insects, bugs, leaf miner, stem borer etc. all pose a threat to citrus production

in Nepal. Ansari et al. (2011) reported that better management practices will contribute in the rejuvenation of the declining orchard. HLB is the main cause of citrus decline in Nepal, according to Bove (2006) and Roistacher (1996), who also warned that “greening will destroy the citrus business in Nepal slowly but surely if essential actions are not implemented in time.” They proposed that the Certification Program should be implemented in Nepal.

Citrus Greening

Citrus huanglongbing (HLB), also known as greening, is the most devastating citrus disease in the world, posing a threat to the industry's long-term viability in major citrus-growing countries (Sheng et al., 2020). The disease has spread to the majority of commercial citrus-growing regions and has been recorded in more than 50 nations globally (Fig 1; CABI, 2020). *Candidatus Liberibacter asiaticus*, *Candidatus Liberibacter africanus*, and *Candidatus Liberibacter americanus* are three unculturable and phloem-limited bacteria associated to the disease. The bacterium that causes huanglongbing has been found in seven of the world's top ten orange-producing countries (Zhang, 2019). *Candidatus Liberibacter asiaticus* is the most common bacteria found in Nepal, and it is spread by the Asian citrus psyllid, an insect vector (*Diaphorina citri*). The presence of citrus psyllid, visual disease symptoms, and other confirmatory tests have recently been detected in several significant citrus production regions of Nepal (Manandhar et al., 2004; Regmi et al., 2010; Regmi and Yadav, 2007). This disease was discovered in numerous economically important citrus-growing districts in Nepal, resulting in significant yield losses (Pokhrel et al., 2020).



The bacteria that cause huanglongbing have been detected in 7 of the top 10 orange-producing countries across the globe. Sources: CAB International's Invasive Species Compendium 2019, Food and Agriculture Organization of the United Nations. Note: Three species of *Candidatus Liberibacter* cause huanglongbing: *Ca. L. asiaticus*, *Ca. L. africanus*, and *Ca. L. americanus*. The Asian form is the most widespread. * Indicates that the disease is present in the area, but to what extent may be unknown.

Fig 1: Citrus growing parts of world showing HLB infestation (Sources: CAB International's Invasive Species Compendium 2019, Food and Agriculture Organization of the United Nations. <https://bit.ly/3JJzHbf>)

Among many factors, Citrus greening disease (CGD) is a primary cause of citrus decline, and its severity is greater in lower belts (up to 900 meters above sea level) (Roistacher, 1996). Therefore, we are focusing this paper mostly on CGD management. CGD is rapidly expanding and presents a serious danger to citrus orchards (Regmi & Yadav, 2007; Knorr et al., 1970). In Nepal, citrus decline was recorded for the first time in Pokhara valley by Thrower (1968). Based on visual observation Knorr et al. (1970) suggested that the citrus decline in Pokhara valley was caused by greening disease and suspected that the disease was introduced from Sharanpur, India with the planting materials introduced to Horticulture Research Center, Pokhara for variety evaluation. Regmi (1982) in a survey found that about 55 % citrus trees in Pokhara valley and almost 100% at Horticulture Research Station, Malepatan were infected with HLB disease in early 1980s. Later, more studies and surveys were carried out in other parts of the country to explore the distribution of the greening disease and its vector (Regmi & Lama, 1988; Regmi, 1994; Regmi et al., 1996 and

Bove, 2006). Greening disease caused by Asian Citrus Psyllid, widely recorded in Nepal (Regmi & Yadav, 2007). Earlier publications revealed that HLB diseases has been reported from most of the citrus growing districts of Nepal namely: Kaski, Tanahaun, Gorkha, Syangja, Dhading, Kavre, Dhankuta (FAO, 2011). Recently, the sample submitted to NAST, Khumaltar from Khotang, Sindhuli, Dailekh and Kailali districts revealed positive result (Paudel, 2015). Chhetri et al. (2019) reported this disease from Salyan district. At present the disease seems prevalent in almost 69 citrus producing districts of Nepal. The huanglongbing or citrus greening disease is number one threat to the future of citrus industry in Nepal and unless this problem is understood and managed, citrus will slowly but surely decline (Roistacher, 1996). Some of the citrus nurseries in the country are located below 1000 masl altitude under open sapling production system. In lower altitude areas, insect vector of greening disease (Asian Citrus Psyllid-ACP) are considered active because of the favorable environment.

Regarding the disease symptoms, it produces asymmetrical blotchy mottling of leaves and profuse flowering during off-season flowering. Further, yellow shoots and twig dieback is evident which lead to sudden decline of fruit production. In case of fruit lopsided, bitter, hard fruit with small, dark aborted seeds are

visible symptoms. Additionally, fruit remaining green even when ripe or ripening from stem end are some unusual symptoms. One of the minute detail while scouting the diseased tree in spring season shows visible psyllids or waxy psyllid droppings.



Fig 2: Citrus greening infected sweet orange tree and leaves (Photo source: D. Adhikari, 2022)

Management of citrus greening disease

The technologies currently available at global level to manage HLB are:

- ▶ Inoculums reduction and vector control (Sheng et al., 2020).
- ▶ Cultivation of healthy sapling and removal of diseased plants.
- ▶ Chemical control (pesticide, nano-technology, GA3 use, peptides and antibacterial peptides, antibiotics) (Ghosh et al., 2018).
- ▶ Better nutrition and orchard management (Acharya & Shrestha, 2021).
- ▶ Guava intercropping with citrus (Hall et al., 2008).
- ▶ Hybrid breeding-use of tolerant rootstock (Pumelo as interstock and rootstock Fying Dragon and US897) and scions Sugar Belly mandarin cultivar.
- ▶ Use of Kaolin as cover spray (Qureshi et al., 2019).
- ▶ Individual plastic cover at early stage of crop (Qureshi et al., 2019).
- ▶ Microbial therapy and transgenic technology.

- ▶ Use of Bio-control agent for the management of ACP (*Tamarixia radiata*) (Chen et al., 2017)

There is currently no cure for the disease, thus proper orchard management measures are critical to maintaining citrus health and sustaining citrus production under HLB strain. Therefore an integrated management approach to manage this malady has been proposed here under. Due to economic and geographical constraints, several technologically advanced solutions for reducing HLB infection in other parts of the world may not be feasible in Nepal at this time. Recent interaction program on fruit nursery certification organized by National Fruit Development Centre, Kirtipur under Department of Agriculture, Ministry of Agriculture and Livestock Development, Nepal on 6-7 Dec., 2021 highlighted the concept of clean plant center for disease free citrus planting materials production. Similarly, Citrus Thematic Working Group Workshop on 13-14 Dec., 2021 jointly organized by PMAMP and NCRP focused on quarantine issue to prevent spread of citrus greening disease in the country.

Citrus Greening/Decline Management strategies

1.0 At National Level

- Reformulation of seed act (2045), special law for citrus nursery establishment and distribution of saplings - Nursery act, Nursery guideline development and enforcement.
- Strict prohibition of seedling/ sapling use from open field nursery, unidentified source and sub-standard quality (Rouse et al., 2007).
- Strict quarantine regulation at international and internal boundary, inter district and inter province quarantine system for transport of citrus sapling.
- Bud-wood certification guideline formulation and strict enforcement - mandatory for all GOs and private nursery.
- Formulation of national level HLB management guidelines which need to be followed by all three level of government (Local, Province and Federal).
- CGD awareness program to the farmers and other stakeholders.
- Survey and surveillance of HLB and its vector ACP, annual program calendar development and training to agriculture technician.
- Development of information system (Web portal) to ACP management on insecticide spray to ACP management.
- Support on citrus greening surveillance and ACP monitoring from Super/zone, PMAMP.
- Support to identify the location specific causes of citrus decline (biotic: diseases such as CTV, root/foot rot and insects like fruit fly; and abiotic factors) and their management.

2.0 At Palika and Provincial Level –

2.1 For New orchard establishment

- Establishment of orchard at least 3 km away from infected area.
- Eradication or keep alternative host (Kamini, Curry leaf, Bael) plants at least 3 km away from Citrus orchards.
- No prior history of HLB should be at new plantation area.
- Soil and environment condition suitable to cultivate citrus.
- Use healthy and identified saplings.
- Follow guava and citrus intercropping practice.
- Follow the management practices of other causes of citrus decline in specific locality such as for the management of root/foot rot: Don't use seedling planting materials, containerized nursery establishment have been recommended.

2.2 For old orchard management

- Plantation of disease free grafted plants from identified source.
- Regular monitoring of HLB disease and its vector.

- Program for diseased plant removal.
- HLB vector survey and management program.
- Program on better nutrition management of citrus trees.
- Plant guava and citrus intercropping practice.
- Prepare and execute citrus greening and ACP surveillance and management awareness campaign.
- Follow the management practices of other causes of citrus decline as per priority of the problem in specific locality.

3.0 By Development sector (I/NGOs)

- No distribution of substandard citrus saplings.
- Management program for citrus greening disease.
- Awareness program on citrus decline management.
- Prepare citrus related program in collaboration with related agriculture offices.

4.0 By Education sector

- Prepare and update course on citrus greening and ACP management.
- Conduct post-graduate research in collaboration with GOs based on citrus

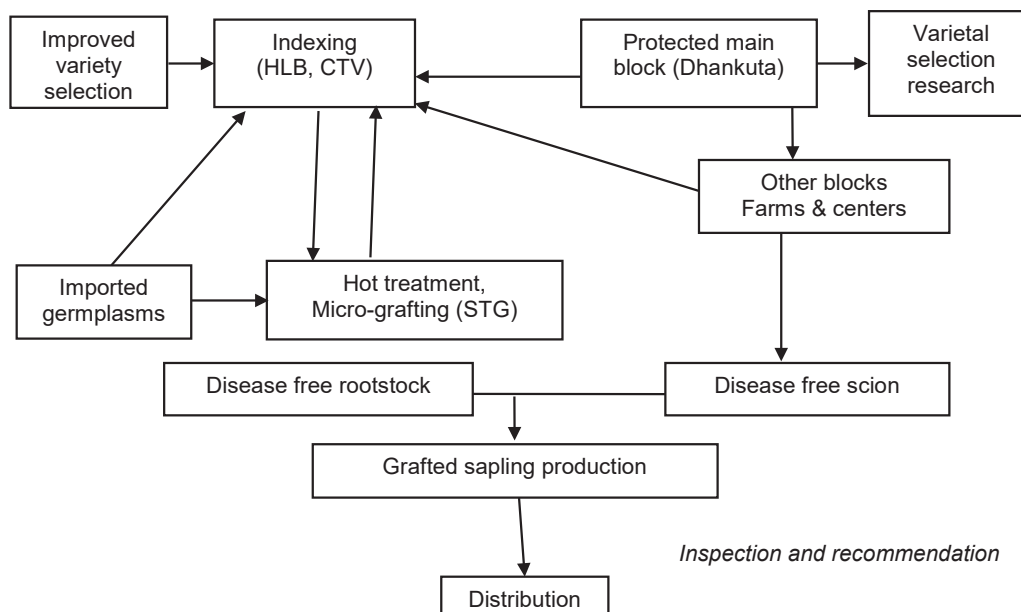
industry need.

- CGD detection service to stakeholders (eg. AFU- Biotechnology Department).
- Focus on long term research project for the management of citrus decline.

5.0 By Research sector

- Research on vector management (use of IPM technique on ACP mgmt., Kaolin use).
- Study on disease management (nano technology-Zinkicide, nutrition management).
- Rootstock selection trial for individual crop at different domain.
- Resistant breeding (rootstock /scion: selection- introduction).
- Individual Plant Protective Cover (IPC) study.
- Provide disease free sapling to nursery (tissue culture).
- Help on disease detection for development sector (PCR, LAMP, ELISA) and bud wood certification. A pathway for citrus bud wood certification has been proposed as follows:

(Source: Regmi and Acharya, 2019)



Conclusion

In conclusion, the production and productivity of the orchards could not be raised sufficiently due to the existence of biotic and abiotic problems. Some of the major factors contributing to the citrus decline problem in Nepal include improperly established orchards and mismanagement, widespread distribution and planting of poor quality planting materials, increasing dryness in soil, lack of proper plant nutrients, and a lack of implementation of recommended technologies. Monitoring the status and causes of citrus decline and their impact on yield, as well as study on the resistance of important citrus cultivars to diseases such as HLB and Phytophthora root rot, canker, scab, insect pests, nutrient deficiencies, and an integrated approach to management, are all important steps in increasing the country's citrus production and productivity. Citrus decline is mainly caused by CGD and other biotic (diseases and insects like root-rot, CTV, fruit fly) as well as abiotic (orchard and nutrient management) are responsible for this malady. Proper orchard management, sound vector control technique and distribution of disease free quality sapling with strict quarantine system both at provincial and districts/ pocket level need to be practiced for sustainability of citrus fruit industry in Nepal.

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