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A Review on Major Diseases of Citrus in Nepal and their Management

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Abstract

Citrus is one of the most important fruit crops cultivated in tropical and subtropical regions of Nepal. Climatic conditions of mid hill regions of Nepal having an altitude ranged between 800 to 2100 meter above sea level are conducive for all types of citrus fruit cultivation. Nepal produced 273,000 tons of citrus in 2019 and ranked 43rd in global citrus production. The average productivity was 9.4 mt/ha in 2017/18.Various biotic and abiotic factors are reported to decline productivity of the citrus in Nepal. Poor orchard management, improper manuring and fertilization, including insect pests and diseases are major factors for citrus decline and low productivity of the citrus in Nepal. A literature review was carried out to explore the common diseases of citrus and their management in the context of Nepal. Along with the diseases of citrus, their casual organisms, distribution, epidemiology, intensity, symptoms, survival or spread, environmental factors, losses incurred and integrated management strategies corresponded to citrus diseases of Nepal gathered and compiled thoroughly from different literature and websites. Different 16 fungal diseases, 42 viruses, 7 bacterial diseases and some nematodes causing diseases on citrus in addition to this many diseases are reported to attack citrus crops in Nepal. Citrus greening (HLB), *Phytopthora* induced diseases, citrus canker, citrus tristeza, twig blight, powdery mildew etc. are major yield limiting diseases of citrus. Anthracnose, sooty mould, pink disease, gummosis, scab disease, citrus root nematodes, 'Ainjeru' are the other diseases for declining citrus production and its quality. Citrus greening and citrus tristeza are major casual agents for rapid decline and citrus root nematode is considered as casual factor for slow decline of citrus.

Keywords: Citrus, Citrus diseases, Citrus decline, citrus root nematode, citrus tristeza

Introduction

Citrus is one of the most important fruit crops of Nepal in terms of area coverage, production and export potential. Citrus has been grown in 62 districts.

Dhankuta, Terathum, Sindhuli, Ramechhap, Dhading, Kavre, Gorkha, Lamjung, Tanahun, Kaski, Syangja, Myagdi, Palpa, Salyan, Dailekh, Baitadi and Dadeldhura are the major producers (Adhikari, 2013/14). It is grown in tropical and subtropical regions and grows well in temperature range of 15-30 ºC with well distributed annual rainfall of 1250 to 1850 mm (FAO & MoAC, 2011). In Nepal, the climatic condition of mid-hill regions having altitude range of 800 m to 2100 m from east to west of the country are considered favourable for all types of citrus fruit cultivation (Lama, 1988). Commercial cultivation of citrus in Nepal started only after 1970 (NCRP, 2010). The citrus is grown in an area of 46,328 ha with only 26,759 ha productive area which accounts total production of 239773 Mt and the productivity is 8.96 Mt/ha (MoALD, 2017). According to MoAD (2014), despite its production in Nepal, 21503.49mt citrus had been imported from India, China and Thailand in the fiscal year 2013/14. Citrus accounted 3% of total fruit exported and 16 % of total fruits imported by volume (MoAD, 2014). Kaini (2019) described that though Nepal has better climatic and soil conditions to grow citrus compared to other south Asian countries, the productivity of citrus fruit in Nepal is subsequently decreasing. Various biotic and abiotic factors are responsible for low and stagnant the productivity and decline of the citrus in Nepal (Subedi et al., 2008). Unsuitable soils, drought, lack proper nutritional management, use of poor quality planting materials, improper orchard management, field incidence of different diseases and insects. Several insect pests and diseases (Chinese citrus fly, citrus greening, canker, root rot etc.) are considered major factors for citrus decline in Nepal (Adhikari et al., 2019). Citrus is susceptible to large number of diseases caused by various pathogens. Timmer et al. (2000) described 16 fungal diseases, 42 viruses or virus like organisms, 7 bacterial diseases and some nematodes causing diseases on citrus. Despite the fact that many diseases are reported to attack citrus crops in Nepal, Citrus greening (HLB), *Phytopthora* induced diseases; citrus canker, citrus tristeza, twig blight, powdery mildew etc. are major yield limiting diseases of citrus (MoAC, 2011). Anthracnose, sooty mould, pink diseases, gummosis, scab diseases are the other diseases for declining citrus production and its quality (Adhikari, 2016/17). Akhtar and Ahmed (1999) noted severe loss of citrus due to these diseases like 22% in Kinnow, 25–40% in sweet orange, 15% in grapefruit, 10% in sweet lime, and 2% lemon. High pressure of the diseases not only cause severe citrus decline syndrome of the tree but also reduce the quality of fruits in citrus growing regions. This paper focused on major diseases of citrus which are considered as major production constraints and leading to citrus decline in Nepal. It has also highlighted the possible management strategies of these diseases targeting to achieve attainable yield of citrus.

Table 1

Major Yield Limiting Diseases of Citrus in Nepal

S.N.	Diseases	Pathogens	Location	Source
A.	**Fungal Diseases**			
1.	Foot and root rot of Citrus	*Phytopthorasp P.parasitica P.citropthora P.palmivora*	Widespread throughout the country	Lama (1980)
2.	Gummosis	*Phytopthorasp*		Lama (1980)
3.	Pink disease	*Erythriciumsalmonicolor*		
4.	Powdery mildew	*Oidiumtingitaninum*	Western region of Nepal	Khadka et al., (1967)
5.	Wither blight (Anthracnose)	*Colletotrichumacutanum*	Western region of Nepal, Kaski	Lama (1979)
6.	Damping off, Dry rot of citrus	*Rhizoctonia*	Throughout the world	Lama (1979)
7.	Citrus scab	*Elsinoefawcetti*	Midwestern region, Rapti	Khadka et al.,(1967)
8.	Greasy spot	*Mycosphaerellacitri*	Western region, Kaski	Khadka et al., (1967)
9.	Sooty ould	*Capnodiumoleaginum*	Western Region, Kaski	Lama (1971)
10.	Blue mould of fruit	*Penicilliumdigitatum*	Throughout the country	Lama (1979)
11.	Green mould	*Penicilliumsp*		
12.	Styler-end rot of citrus/core rot of citrus	*Alternariacitri*	Eastern Region, Illam	Khadka et al., (1967)
B.	**Bacterial Diseases**			
1.	Citrus canker	*Xanthomonas axonopodispv. Citri*	Widespread throughout the country	Anonymous. 1990-91. Plant Pathology Division, Khumaltar.

2.	Citrus greening	*Candidatus liberobacterasiaticus*	Widespread throughout the country	Lama T.K (1980)
C.	**Viral Diseases**			
1.	Citrus tristeza	Citrus tristeza virus (CTV)	Throughout the country	Lama T.K (1980)
2.	Citrus leprosis	Citrus leprosis virus (CiLV)		
D.	**Nematodes**			
1.	Citrus Root Nematode	*Tylenchus semipenetrans*	Throughout the country	Manandhar HK and P Amatya (1985)
E.	**Phanerogamic Parasitic plants**			
1.	Ainjeru of citrus	Parasitic angiosperm	Throughout the country	Lama T.K (1980)

Source: National pest status record of Nepal

Fungal Diseases of Citrus in Nepal

1. *Phytopthora* inducing diseases

The all-inclusive term "Phytophthora root rot" indicates a complex disease which is caused by several soil-borne species of *Phytophthora* and is considered as a major oomycetes disease of citrus globally (Sadowsky, 2006; Tuset, 2006). The symptoms of the diseases caused by *Phytopthora* are foot rot, root rot, crown rot, gummosis, leaf fall and brown rot diseases (Poudyal & Shrestha, 1995). Ten species of the oomycetes are reported to cause diseases on citrus but three species of them are deleterious to the citrus plant; *P.parasitica (*Syn*P.nicotianae), P.palmivora* and *P.citropthora* (Graham & Menge, 2000). The distributions of these species are affected. *P.parasitica* requires warm season, generally does not affect above ground part of citrus and active at May to November whereas *P.citropthora* requires cool season and active at November to March. The disease is more prevalent in orchard established at an altitude of 900-1400 masl. The disease was first reported in Nepal in early 1970s from Pokhara. In Nepal, most of the mandarin trees are grown from seedlings which are reported to be more susceptible to this disease (FAO & MoAC, 2011). The development and spread of the disease is favoured by high soil moisture, excessive irrigation; poor soil drainage and prolonged monsoon. The loss incurred

by root rot was on an average around 5% while the damage caused by gummosis was estimated to be average about 1% (Menge & Nemec, 1997). The seedlings rot in nursery caused by *Phytophthora* in severe conditions may cause 80% of seedlings death (Cacciola & di San Lio, 2008).

Rotting of foot and crown roots and oozing (gummosis) are the characteristic symptoms of the *Phytophthora* diseases. Dull chlorotic foliage is the initial symptom of the disease where midrib, main lateral veins and band of leaf tissue bordering them become yellow leaving rest of the leaf normal in colour (FAO & MoAC, 2011). *Phytophthora* kills the bark and blocks the water and nutrients transportation of plants, after girdling the tree,

Management: Use of Trifoliate orange as rootstock can reduce the disease severity. Root rot and gummosis disease can be controlled by exposing the affected roots on sun during dry season, drenching with Bordeaux mixture in February and May. Spraying of anti-rot @ 10 ml/liter of water at the active growth stage is recommended for Nepal (Ghosh, 2008).

2. Powdery Mildew of Citrus

The Powdery mildew of citrus is caused by *Oidium tingitaninum* Syn. *Acrosporiumtingitaninum.* The disease is more prevalent in a warm climate and with high relative humidity especially during May-June. Powdery mildew was found to be major problem in eastern Nepal since 1977 where high humidity with high temperature remains for long (FAO & MoAC, 2011). It is serious between 1200 to 1400 masl altitude. The most susceptible citrus species to powdery mildew disease are mandarins, sweet oranges and tangerines. Infection usually appears first on new flushing leaves and all the aerial parts may be affected. The disease not only causes damages on the new flushes causing defoliation but also causes die back and fruit drop (FAO & MoAC, 2011). The most common symptoms of the disease are the appearance of powdery masses on leaves and young twigs. The affected fruits drop with a gentle touch and the dieback of the leaves was observed. The disease produces tiny, powdery spores on leaves and spores are spread by wind, people clothing, equipment etc.

Management: Use of disease-free certified planting materials. Pruning to avoid unnecessary branches and allow good air circulation to reduce the disease incidence. Spraying 80% wettable sulphur at the rate of 2gm/liter of water at the onset of the disease at 2 weeks interval or Karathane at the rate 2ml/liter of water at 10-15 days intervals is also effective to control the disease.

3. **Wither Blight (Anthracnose)**

Anthracnose is another important disease that causes fruits drop reported from many citrus growing countries of the world (Brown, 2003). The disease was reported from Kaski, Pokhara in citrus (Lama, 1979). Lama (2001) reported anthracnose disease of citrus as one of the fugal disease of citrus in Pokhara valley. The disease is caused by *Colletotrichum gloesporioides*. The main symptoms of the disease are dropping of leaves, fruits and die back of twigs. When this disease attacks in fruit that develop black-brown areas at stem-end, which turn yellowish and leads to pre-mature dropping.

Management: Hot water treatment of seeds or fruits (48^0C for 20 minutes) can kill the fungal residues and prevent the spread of the disease. Copper sulphate fungicides reduce the risk of infection. Azoxystrobin and Chlorothalonil can be effective to control anthracnose disease of citrus.

4. **Citrus scab**

Citrus scab is mostly found in moist humid citrus production regions. The disease is caused by *Elsinoëfawcettii. Elsinoëfawcettii* causes citrus scab (formerly sour orange scab and common scab) on various species and hybrids in the Rutaceae family worldwide, whereas *E. australis* causes sweet orange scab, primarily on sweet orange and some mandarins, and has a limited geographical distribution (Chung, 2011). Khadka et al. (1967) reported the citrus scab from the Midwestern region of Nepal

The disease is more prevalent Rangapur lime, jyamire, citrange rootstock and scion of Murcott, tangarine etc. (Acharya et al., 2019). Fruits, leaves and twigs of susceptible cultivars of citrus like lemons, grapefruits and many tangerines and their hybrids are affected and reduce the fruit quality of citrus(Chung, 2011).The disease produces slightly raised, irregular scabby or wartlike outgrowths. The scabs are grey or pinkish at first and become darker with age (Hardy & Donovan, 2007).Scab lesions can be seen on leaves as early as 4 days after infection and on fruit around 7 days after infection. Severely affected leaves often become deformed and scabby. Similar scabby lumps are also formed on twigs and fruit. The affected fruits tend to have a flatter corky appearance. Citrus scab seldom reduces yield, but may reduce the value of the fruit by as much as 50% if uncontrolled (Chung, K. R., 2011).The frequency and duration of humidity and source of inoculum principally affect the severity of the citrus scab (Agostini *et al*., 2003).At optimum temperature (24–28°C), a short wetting period (2–3 h) is sufficient to induce conidia formation, germination and infection (Agostini et al., 2003).

Management: Collection and destruction of diseased parts can reduce the disease spread. Spraying of 1% Bordeux mixture during flushing in the nursery is effective to control the spread of the disease. Copper based fungicides are found effective to control disease. Azoxystrobin, trifloxystrobin, Pyraclostrobin, Carbendazim etc. are sprayed three-four times; first at spring flush 2-3 inches (Can be omitted if the severity is light), second at during petal fall and third after three weeks after petal fall.

5. **Sooty Mold**

Sooty mold is a black, non-parasitic, superficial growth of fungi on plant surfaces and the fungi feed on honeydew produced by phloem-feeding insects (Nelson, 2008).Sooty mold is not a specific disease rather it is the development of fungi like *Capnodiumcitri, Aithalodermacitri* etc. on the surface of the leaves over the secretions of different insects (Acharya et al., 2019). Lama (1971) reported sooty mold of citrus for the first time in Kaski district of Nepal. Air current, rain splashes and rain washes spread the spores or disease inoculum and deposit over the honey dew secretions deposited by phloem feeding insects mentioned above. Black encrustation is formed which affect the photosynthetic activity by reducing the photosynthetic area. The leaves, fruits and stems are thoroughly covered with black sooty masses and weaken the plants.

Management: Management of honeydew secreting insects through insecticides help to reduce the disease severity. Bordeux mixture (1%) can be used for effective management of the disease.

6. **Greasy Spot of citrus**

The greasy spot disease is foliar and fruit disease of citrus primarily occur between June to August and most prevalent disease of tropical and subtropical citrus growing regions (Kucharek & Whiteside, 1979). It is caused by *Mycosphaerellacitri.* The host range *of M. citri* is limited to the Rutaceae. Development of the epiphytic growth of the pathogen requires high temperatures and extended periods of high humidity or free moisture (Mondal &Timmer, 2006). Khadka and Shah (1967) reported the disease greasy spot in citrus from Kaski district of Nepal for the first time. Appearance of dark yellow to brown or black lesions on underside of mature leaves which later develop into darker and chlorotic spots on upper surface of the leaves are the primary symptoms associated with greasy spot disease (Futch & Timmer, 2005). During fall the premature falling of affected leaves occur and in winter reduced tree vigour and yield of citrus can be observed in diseased tree. The disease also affects fruits.

Management: Greasy spot is controlled effectively with copper fungicides or single spray of the petroleum oil provided spray timing is correct and the placement of the material is on the underside of the leaf (Futch & Timmer, 2005).

A. Bacterial Diseases of Citrus

1. Citrus Greening disease

Citrus greening disease is one of the most devastating diseases of citrus all around world (Bové, 2006). Citrus greening is also referred to as Huanglongbing (HLB) disease in the Asia region. The disease was reported from China in 1919 (Berk, 2016) and is now known to occur in more than 40 different countries of Asia, Africa, South and North America. The disease is major cause of citrus decline. Before it was identified as one disease, it became known by various names: yellow shoot (huanglungbin) in China; likubin (decline) Taiwan; dieback in India; leaf mottle in the Philippines; vein phloem degeneration in Indonesia; and yellow branch, blotchy-mottle, or greening in South Africa (Graca, 1991). The disease was first reported in Nepal in 1968 A.D from Pokhara valley (Thrower, 1968). It was assumed that the disease was entered Nepal from India through planting materials and later on it was spread over the country. The disease is considered as main cause of citrus decline in Nepal (Regmi &Yadav, 2007). Regmi et al. (2007) reported that the disease is widespread over citrus growing pockets such as Lamjung, Syanja, Kaski, Dhading, Tanahu districts of Nepal. The disease is caused by gram negative bacterium. Three species of the bacterium was reported to cause the CGD; *Candidatus Liberibacterasiaticus,Candidatus Liberibacterafricanus* and *Candidatus Liberibacteramericanus* respectively prevailing in the continent of Asia, Africa and South America. These species differ in their pathogenicity due to a combination of environmental conditions and insect vectors (Jagoueix et al., 1996). *Candidatus liberibacter asiaticus* strain is primarily distributed in Asia and it is heat tolerant and able to cause symptoms at temperature greater than 30^0C. Loss of 30-50% of the tree was reported due to citrus greening (Johnson et al., 2014).The symptoms of citrus greening was noted on about 55% of citrus trees in Pokhara valley and 100% in Horticulture Research Station in 1980s (Regmi, 1982).The causative bacterium is spread over by an insect called Citrus Psylla which acts as vector of the disease. The insect is specially found in tropical region below 1100 masl. Most of the commercial citrus species of Nepal like mandarin and sweet orange are very susceptible to the disease while acid lime is slightly tolerant, but it carries HLB bacterium which could be a source of inoculums (Poudyal, 2015).

The typical symptoms of the disease are gradual decline of the tree growth having small acute interveinal chlorotic and dull green leaves. Fruits size gets

reduced and juice of the fruit become sour (Budathoki & Pradhanang, 1990). The affected leaves develop yellow and green pattern areas giving a "blotchy mottle" appearance. This is the most characteristics foliar symptoms and the patterns are asymmetrical on the two halves of the leaf (Bove, 2006).

Management: Use of healthy planting materials and control of insect vector by dimethoate (0.05%) is mandatory**.** Proper management of the orchard and spraying of copper based fungicides reduced the infection of the disease (Burlakoti & Khatri-Chhetri, 2004).

2. **Citrus Canker**

Citrus canker or cancrosis or Asiatic citrus canker is a very important disease of the most commercial citrus cultivars (Gottwald & Graham, 2000). Lee (1918) reported that it may have arisen in southern China, and he assumed *Fortunella hindsii* to be the wild host plant.The disease causes extensive damage to citrus which is probably originated in Southeast Asia or India, and now occurs in more than 30 countries (Jetter et al., 2000). Schaad et al. (2000) proposed and placed citrus canker and citrus bacterial spot strains within *Xanthomonas* as a species *citri* (A strains), *aurantifolli* (B and C strains) and *citrumelo* (citrus bacterial spot strains). Most recently, Brunings and Gabriel (2003) proposed the retention of *X. citri* as a species that includes only citrus canker strains (A and B-C).

Table 2

Different forms of Citrus canker Pathogen and their Distribution

Characteristic canker form	**Citrus canker Pathogen**		
	A	**B**	**C**
	*Xanthomonasaxonopodis*pv. *citri*	*Xanthomonasaxonopodis*pv. *aurantifoli*	*Xanthomonasaxonopodis*pv. *aurantifoli*
Distribution	Asia, Africa, South America	Argentina, Uruguay, Paraguay	Brazil, Mexico
Host Range	Wide	Limited	Limited
Major Host	Citrus species	Lemon	Mexican Lime

Source: Das (2003)

The disease is more prevalent and active during monsoon season. An essential diagnostic symptom of the disease is citrus tissue hyperplasia (excessive mitotic cell divisions), resulting in cankers (Gabriel et al., 2000). The conspicuous raised necrotic lesions develop on leaves, twigs and fruits (DoA and FAO, 2011). The cankerous lesions measure 1-9 mm diameter on leaves and up to 1cm diameter on fruits and

stems. The lesions coalesce with each other and lead drying of the affected part. The formation of shot hole can be noticed on infected tissues. The symptoms appear all the above ground part of the plant.

Management: The lime is very susceptible and special care should be taken to manage canker in citrus. Chemical sprays of copper based pesticides (Dhakal et al., 2009). Pruning and destruction of infected twigs before monsoon is necessary. Three to four sprays of copper oxychloride (0.3%) in combination with streptocycline 100 ppm or Streptomycin Sulphate (500 ppm) at monthly interval after the onset of monsoon is recommended (DoA and FAO, 2011).

B. Viral Diseases

1. Citrus Tristeza Disease

Citrus virus and virus-like diseases were unknown in Nepal prior to the importation of grafted citrus from Saharanpur (Uttar Pradesh) in India in the 1960's (Lama, 1996).'Tristeza' is a word which describes the sad appearance of the tree. Citrus tristeza disease is one of the most devastating diseases causing extensive damages to the citrus trees in world. The disease is caused by virus called as citrus tristeza Virus (CTV). CTV is a member of the closterovirus group and is considered as one of the most economically important virus of citrus (Bar joseph et al., 1992). The disease was reported to be more severe in Brazil and South Africa till 1960s when the citrus industry was established on sour orange rootstocks (DoA & FAO, 2011).It is still a severe problem in many countries where the severe strains of CTV exists or introduced from abroad without following strict quarantine procedures and there are reports of about 12 strains in the world varying from very mild strain to very severe strain (DoA and FAO, 2011). The virus was first reported in Nepal in 1971 from Pokhara valley in lime (Knorr & Moin-Shah, 1971). The disease was vectored by aphids, *Toxoptera citricida* and *T. aurantii*and the disease was extended throughout the Nepal from east to west (Tomiyasu & Verma, 1999). Aphids acquire the virus semi persistently for 5 minutes to hours and transmit it while feeding the trees. Large numbers of mandarin trees affected at Pokhara, Gorkha and Lamjung (1000m) were affected by CTV (Tomiysu & Verma, 1999).The diagnostic symptoms of CTV infection are honeycombing, pitting of inner face of the bark of the trunk, severe stem pitting develops in species like lime, grape fruit, pummelo, sweet orange, sweet lime etc. However, mandarins are non-symptomatic and are not damaged; only limes are symptomatic and severely damaged by CTV. Definite symptoms of vein clearing and stem pitting in indicator plants like Indian Kagzi lime, Mexican lime, etc. during greenhouse assay confirms the virus. The virus is graft transmissible and is not seed-borne (Wallece, 1978). The virus can also be transmitted through knives used during grafting.

Management: Use of healthy planting materials and tolerant rootstocks, such as rough lemon, trifoliate orange, citranges, etc. can keep the disease under control (DoA & FAO, 2011). Vector control through botanical (neem seed extracts) and chemical pesticides (0.05% Dimethoate or 0.02% chlorpyrifos). Impose of strict plant quarantine is most essence to control the spread of disease into the country or within the country.

C. **Nematode Disease**

Citrus Root Nematodes *(Tylenchus semipenetrans)*

Nathan Cobb described citrus root nematode as a new species, *Tylenchulussemipenetrans*, which then was identified as the causal agent of slow decline in citrus in 1913. The nematode is found causing disease worldwide in citrus growing areas (Duncan, 2005). The nematode was originally from Asia, it spreads worldwide with infested planting stock. Most studies estimate yield losses due to *T. semipenetrans* to be in the range of 10% to 30% depending on the level of infection(Verdejo-Lucas and McKenry, M. V., 2004). Among the diverse soil textures, the nematode, *T. semipenetrans*is dominant pathogenic species in most citrus regions (Verdejo-Lucas & McKenry, 2004).The disease is a major and common disease of citrus prevalent in all citrus growing areas of Nepal (Karki, 1997). Fluctuations in soil salinity from high to low favours nematode reproduction, while sandy soils poor in organic matter hinder population increase (Timmer et al., 2003). The life cycle of the female nematode from egg to egg ranges from 4-8 weeks. Along with the Citrus species the nematode affects trifoliate orange, grapevines, persimmon, lilac and olive (Inserra et al., 1994). The above ground parts of the plants have reduced growth, die back from the tip of the plant, reduced in fruit size and production of the citrus (Acharya et al*.,* 2019). Root stunting and root decay by *Tylenchulussemipeneterans* along with reduced leaf and fruit size, canopy thinning, and exposure of bare crown limbs are the most conspicuous symptoms of slow decline and result in yield suppression (Duncan, 2005).

Management: Planting healthy plantlets and intercropping with marigold reduce the nematode incidence in soil. Use of resistant Swingle citrumelo (Galeano et al., 2003) rootstocks and trifoliate orange rootstocks (Acharya et al., 2019) is a promising strategy for preventing the damage induced by *Tylenchulussemipenetrans* to citrus. Soil drenching with Dichlorofenthion @at the rate 45ml/ha or Ethoprophos at the rate 40gm/ha can effectively manage the nematode population in soil.

D. Phanerogamic Parasitic plants

'Ainjeru' of Citrus

The mistletoes constitute a polyphyletic group of flowering parasitic plants and are commonly known as "Ainjeru" or "Lisso" in Nepali. Of the over 1300 mistletoe species occurring worldwide, 19 species of mistletoes are available in Nepal (Devkota, 2005). It is the member of family Loranthaceae (Gill & Hawksworth, 1961). 'Ainjeru' are obligate stem parasites which may be holo or hemiparasite and have haustorium for the absorption of nutrition from the host, attachment to the root and penetration into the host. Mistletoes have emerged as the most serious parasites, resulting in a substantial crop loss in perennial fruits such as mangoes, jacks, amla, annona, citrus, guavas, pomegranates, mulberries and sapotas, especially reaching up to 80% in mangoes (Mathew & Duraimurugan, 2002). Lama (1980) reported the Mistletoes growing around and parasitizing citrus plants throughout the country. Swellings or tumourous growth of the infected tissues is observed at the point where haustorium is produced. The affected host plant becomes stunted. The parasitic plant feeds and leads to dieback and death of the branches. The dispersal of seeds of the plants is through birds and animals.

Management: Remove infected branched by cutting 1cm below the infected part and is suggested to prevent further spread of the Ainjeru in citrus. Base banding with 1% 2,4-D – for xylem translocation that results in non-regenerative parasitic mortality and two consecutive foliar sprays with either 1% ethephon or 60% diesel, with the second spray on leaf re-emergence was reported effective for ainjeru (Deepu & Habeeburrahman, 2013).

Conclusion

The diseases discussed and described above are more or less destructive leading to mild to severe loss in citrus production in Nepal or all the citrus growing areas of the world. The review is intended to provide economic importance of the various diseases which will direct the development of management practices for improved citrus production practices. Moreover, exploration and proper disease identification will be important to help to understand more about the diseases prior the intervention. For the effective management of the diseases an integrated approach should be employed through nutritive, biological or chemical controls. Proper orchard management is mandatory to keep the citrus orchard free from pathogens and parasitic pests. Some of the rootstocks like Trifoliate orange, Rangapur lime, Troyer citrange, Swingle citrumelo are found resistant or tolerant rootstocks against various diseases of citrus. Studies on epidemiology, diagnosis, yield loss and management of citrus diseases seem to be quite behind and have to be focused.

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