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Problems and Future Prospects of Darjeeling Mandarin in Darjeeling and Sikkim Hills (A Review)

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Abstract—*Darjeeling mandarin (Citrus reticulata L.) is one of the most important cash crop of Sikkim and Darjeeling hills. It's cultivation in the hills is since time immemorial. However, during recent years the productivity of this crop has decreased due to various biotic and abiotic stresses. Some of the major reason of low productivity is lack of quality planting material, many severe pest and disease attack and less technical know-how in the cultivation aspects. Therefore, there is an urgent need in the production of quality planting material and also management of severe pest and disease through organic measures.*
Keywords: Darjeeling mandarin, cultivation, pest and diseases, problems and prospects.

INTRODUCTION

Mandarin orange (*Citrus reticulata*) is the most common among citrus fruits grown in India. It occupies nearly 50% of the total citrus area in India. Mandarin group includes all types of loose jacket oranges commonly called Santra or mandarin such as Nagpur Santra, Coorg Santra, Khasi Mandarin, Darjeeling Mandarin etc. Darjeeling mandarin represents the most important commercial fruit of Sikkim and is similar to the Nepal or Assam or Sikkim mandarin. In Sikkim and Darjeeling hills, mandarin orange is being cultivated since time immemorial. The valleys of Teesta and Rangit rivers and their tributaries of Sikkim and adjoining Darjeeling district of West Bengal offer an ideal himalayan climate for the cultivation of Darjeeling mandarin. In Darjeeling and Kalimpong, only one variety, Darjeeling mandarin is cultivated on commercial scale. Production and productivity of any cash crop is directly dependent on its health status which is correspondingly related to pest and disease management along with its nutritional input. *Citrus reticulata* (Blanco) is the most extensively grown citrus species in India. It is commonly known as mandarin and Darjeeling mandarin is one of the ancient commercial crop that is being cultivated in Darjeeling and Sikkim hills. Besides three more different strains of mandarin cultivated in India viz. Khasi mandarin grown in northeastern states, Nagpur mandarin grown in Maharashtra, Coorg mandarin grown in south India. It is also known as Darjeeling or Sikkim orange. This variety is generally propagated from seeds. The tree is generally medium to tall with an erect habit, very densely foliaged, both thorny and thornless, and a prolific-bearer. Fruits are depressed, globose to oblate and weigh 100-225 g; bright orange; surface smooth, glossy, short-necked, slightly ribbed, rind thin, firmness soft to very soft, segment 8–12, flavour agreeable, juice abundant, sweetness and acidity well-blended, seeds about 10 per fruit, medium-sized and green when cut.

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PROBLEMS IN DARJEELING MANDARIN

1. Lack of quality planting material.

The main reason of low productivity in Darjeeling mandarin is the lack of healthy quality planting material. Farmers of the hills mostly propagate their mandarin through seeds. Most of the seeds obtained are disease (such as Citrus tristeza Virus CTV, Citrus Mosaic Virus CMV) affected mother plants. Therefore, the plants raised through disease affected are not healthy and over the years the productivity also decreases.

2. Attack of Pest and Diseases

The mandarin cultivation in Darjeeling has shown a massive decline due to various pathological, entomological and nutritional stresses. The global scenario reflects that citrus production is mostly affected by fungal, bacterial and virus diseases along with pests. Some local edaphic and climatic factors influence intensely to rank their importance as major pests like trunk borer, fruitfly and citrus psylla which are predominant insect pests for Khasi and Darjeeling mandarin. In addition to direct damage some of the insect pests act actively as vectors of some deadly diseases like Citrus Tristeza Virus, psylla with greening and leaf-miner with canker. Even in the orchards low elevation of Darjeeling hills and Sikkim, citrus psylla has been reported to cause greening disease.

1. Citrus Tristeza Disease

The disease is caused by *Citrus Tristiza Virus* (*CTV*). CTV causes severe loss in mandarin production in Darjeeling hills (Biswas *et al*. 2008; Mukhopadhyay *et al*. 1986).This disease is primarily spread through the use of diseased bud-wood. Citrus aphid (*Toxoptera citricida*), vector of the disease transmits this virus in the healthy orchards. The disease symptom includes quick decline, dwarfing, stem pitting to

yellowing of seedlings (Gurung, 1989). As the disease advances, severe chlorosis and mottling can be seen. The roots of the affected plants start rotting and plants die. After 7-8 years, the branches of the affected plant dry up severely and the plants wilt completely. A high titre of CTV was recorded in the tender shoot bark, leaf petiole and mid rib of seven citrus spp. but pumelo, trifoliate and kumquat were found to be free of CTV infection when tested in DAS-ELISA and reverse transcription polymerase chain reaction (RT-PCR). A higher concentration of CTV was recorded in the older mandarin plants, which might be due to the increase of CTV concentration with age of the plant and multiple inoculations by aphids in older plants (Ghosh *et al*., 2014).

2. Citrus Greening disease

The causal agent of this disease is phloem limited bacterium. This disease is spread through grafting and citrus psylla (*Diaphorina citri*). In this disease, varied chlorotic patterns on leaves are noticed. Veins of affected leaves turn yellow, leaves remain undersized and foliage become leathery and turns dull green. Diseased fruits are valueless owing to small size, distortion, low juice and insipid taste.

3. Gummosis disease (Causal organism: *Phytophthora palmivora, P. citrophthora, P. nicotianae* var. *parasitica*):

The characteristic symptom of the disease is exudation of gum from bark of the tree trunk. The leaves of affected plants, turn yellow and show blight symptoms. The bark shows conspicuous brown staining along with hardened masses of gum on the surface. The bark cracks open and in the later stages dry up and fall off, exposing the wood for secondary infection by other microorganisms. In severe cases, the bark is destroyed by complete rotting, the trunk exhibits a characteristic girdling and the tree eventually dies. Prior to death, the plant usually blossoms heavily and dies before the fruits mature. In such cases, the disease is called collar rot or foot rot. The trunk should be painted upto 50-75cm twice a year with Bourdeux mixture 1% to control the disease.

4. Powdery mildew (Causal organism: *Acrosporium tingitaninum*):

The disease appears as white, cottony or powdery growth on all aerial parts of the affected plant. The affected leaves show yellowing and crinkling; and they have distorted margins. The cottony growth becomes black and severely affected leaves dry up or drops off prematurely. The symptoms are more severe on the upper surface of the leaves, but are also present on the lower surface. In severe infections, young fruits also get covered by mildew growth and drop off prematurely. Consequently the yield is reduced considerably. Immediately, after the cottony growth is observed spraying of 0.3% Sulfex or 0.2% Carbendazim, three times at 15-20 days interval effectively controls the disease.

5 . Citrus canker disease (Causal organism: *Xanthomonas axonopodis* pv. *citri*)

It is most serious bacterial disease of citrus crops during rainy season and it can cause severe losses. The disease appears on leaves, twigs, petioles, branches, fruits, fruit-stalks and thorns. Initially, the symptoms on leaves appear as yellowish, small, raised translucent spots/ lesions, which gradually enlarge 2-4 mm in diameter and appear as raised rough brownish pustules. Later, the epidermis over the spot ruptures to expose a crater-like spongy, tan-coloured tissue. A characteristic yellow halo surrounds the spot till it becomes old. Cankered fruits drop off prematurely. Canker lesions are confined to the rind only and do not penetrate into the flesh of the fruit. The marketability of the infected fruits is seriously affected.

6. Citrus scab (Causal organism: *Eisinoe fawcetti*):

Scab is one of the major diseases in the hilly tracts where low temperature and high humidity prevail. It is common in Darjeeling hills, Sikkim, Assam and other North Eastern States. The disease attacks on leaves, twigs and fruits. Small, raised, corky lesions appear usually on the underside on the leaves. The affected leaves often become distorted, wrinkled, stunted and de-shaped. The opposite surface corresponding to the warty growth shows a circular depression with a pink to red centre. The twig infection also results in similar lesion and the affected twigs are ultimately killed. On the fruits, scabby or corky lesions develop and they soon coalesce affecting larger area on the fruits. The surface becomes rough and distorted and fruit may drop off prematurely. Humidity and rainfall play a very important role in the development of scab.

Insect Pests

Major insect pests problematic to mandarin orange in North Eastern Hill regions of Darjeeling and Sikkim are leaf miner, citrus psylla, citrus fruit sucking moth, citrus stem borer etc. These major insects are as following-

1. Citrus leaf miner (*Phyllocnistis citrella*):

It is a common pest of citrus crops in India. The adult of this pest is a minute silvery white or greyish moth. Usually leaf miner is more active during their growth period *i.e.*, in spring and rainy seasons. Tender leaves are attacked and leaf miner larvae feed on the epidermis, producing silver coloured serpentine mines, generally on the lower surface. A heavy attack may lead severe defoliation. Kalidas and Shivankar (1994) reported that more than 80 per cent nurseries were infested by this pest in India and of the total damage caused by the pest complex of citrus, 30 per cent was claimed by P. citrella alone (ESI New Delhi 1984).

2. Citrus psylla (*Diaphorina citri*):

The damage is mainly caused by the nymphs of citrus psylla, which suck the sap from the leaves, young shoots, buds, flowers and tender branches; flowers shed in large numbers.

The infested leaves curl and fall off prematurely. The nymphs secrete honeydew like substance on which sooty mould fungus develops. The sooty mould fungus does not allow the plants to grow vigorously by affecting its photosynthesis, adversely. Citrus psylla is also reported to be a vector of citrus greening bacterium and indirectly damages the plants more.

3. Citrus Fruit flies (*Bactrocera dorsalis*):
Sometimes, these are very serious pests in Darjeeling and Sikkim hills, especially during the monsoon season. Some 20 to 30 per cent of loss is caused by the fruit fly. In India, fruit fly (*Dacus spp*.) is a major cause of fruit drop which is even true for Darjeeling mandarin. The fruit flies lay eggs under the ripening fruit rind by means of its piercing ovipositor. The eggs hatch out within few days and the maggots start feeding inside fruits. These maggots spoil the taste and market value of these fruits. The affected fruits can be easily distinguished by the presence of a rotten, round patch at the place where it was pierced by the flies. Affected fruits fall on the ground. The maggot pupates in the soil and emerges as flies after 7-10 days.

4. Lemon butterfly (*Papilio demoleus*):
Lemon butterfly (*Papilio spp*.), is very attractive butterfly of the orchard but its larve cause a considerable damage by feeding leaves causing defoliation. These insects are more damaging in the months of March–May and again in August–October.

5. Aphids (*Toxoptera citricida*):
About 25 aphids have been reported to as Citrus aphids around the world. Indian species include black citrus aphid, *Toxoptera aurantii*, brown citrus aphid, *T. citricidus*, green citrus aphid *Aphis citricola* and melon aphid, *Aphis gossypii*. Adult 4 and nymphs suck the sap from tender leaves and shoots resulting in devitalisation of the plants. Citrus aphids are more important with respect to the spread of *Citrus Tristeza Virus* in citrus orchards. Brown citrus aphid is the main vector of this dreadful virus.

5. Shoot borer/Trunk borer:
Citrus trunk borer (*Monohammus versteegi*) is a serious insect pest of Khasi and Darjeeling mandarin. Affected branches gradually dry up and the leaves wither away. Nearly 40 per cent of total damage is caused by the borer in West Bengal.

3. Less technical Knowhow on cultivation aspects.
One of the major problems in the low productivity of Darjeeling mandarin is due to the poor orchard management and general negligence. Farmers don't follow the proper scientific cultivation aspects right from selecting the proper planting material to the spacing requirement, nutritional aspects. The growers generally do not follow proper spacing requirements; moreover, manure and fertilizer application is also limited to those orchards. Plant protection measures against major pests and diseases are inadequate (Hore and Barua 2004). As a matter of fact, due to ignorance, difficulties in the cultivation in hilly terrain coupled with poor marketing facilities, the cultivators are reluctant to take care of their orange orchards and satisfied with the harvested fruits as nature's gift. (Singh *et al*. 2006).

Ghosh (1978) reported that general neglect, mixed planting and undesirable intercropping, improper spacing, vigorous weed growth, inadequate nutrition (particularly Zn and Ca), infection of *Phytophthora* root rot, gummosis, powdery mildew, canker, scab diseases and attack of insects and pests like borers, aphids, scales, mites, leaf miners are common in mandarin oranges, which Growing of undesirable intercrops is also a matter of concern (Upadhyaya 2000, Yadav 2000). Unsuitable intercrops may cause serious root injury, particularity to feeder and fibrous roots. Undesirable intercrops like maize, ragi, buckwheat, ginger etc. are being grown in the orange orchards.

FUTURE PROSPECTS

Darjeeling mandarin is one of the most important fruit crops of Darjeeling and Sikkim hills of North Eastern region of Himalaya. It plays an important role in providing energy, food and certain vitamins. Besides, it is a good source of income for the growers especially in these challenged areas. Darjeeling mandarin has enormous potential for its commercialization. Even though commercialization of this particular crop has been started, it is still at a budding stage. The significance of this crop is magnified not only because of its nutritional value but also owing to its medicinal use. Budwood certification programmes in each citrus growing region as an emergent need of the day so that appropriate planting material is used for raising orchards and the grower of northeastern region can be able to increase productivity. Use of biotechnological methods to produce biotic or abiotic stress tolerant Darjeeling mandarin is another area of research which needs to be explored to enhance the productivity of the crop.

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