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Viral Diseases of Large Cardamom their effect on Production and their Management

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Abstract: *Large Cardamom is common cultivated spice crop in Nepal as well as in India and Bhutan. Large Cardamom is prone to many diseases, among them viral diseases are annihilative which causes sententious yield loss. Field surveys were conducted during different seasons of 2016-17... Chirke is serious as far as rate of spread is concerned and Foorkey is serious as far as yield loss is concerned. Chirke is caused by Large Cardamom Chirke Virus (LCCV), a new virus species under the genus* Macluravirus, *family* Potyviridae and *is characterized by mosaic with pale streak on the leaves. The streaks turn pale brown resulting in drying, withering of leaves and finally death of the plants. The flowering in diseased plants is debased. The chirke disease is transmitted by mechanical sap inoculation and also by aphid, Ropalosiphum maidis Fitch (Raychowdhury & Chatterjee 1958; 1961; 1965a). The cultivar Kopringe is resistant to chirke. Excessive sprouting and formation of bushy dwarf clumps at the base of the mother plants that gradually die, characterize the foorkey disease caused by Cardamom Bushy Dwarf Virus (CBDV). The primary promulgation of the disease from one area to another is through infected rhizomes and further spread within the plantation by aphids, Pentalonia nigronervosa Cog, Micromyzus kalimpongensis (Hemiptera: Aphididae).*

Keywords: *Large Cardamom, Chirke, Foorkey, Pentalonia nigronervosa, Ropalosiphum maidis*

1. INTRODUCTION

Large cardamom (*Amomum subulatum Roxb*.), also known as the "Queen of spices, "belonging to Zingiberaceae family is the most prominent cash crop, attracting high revenues across the globe. In Nepal, cardamom accounts for 7% of total agricultural exports, ranking second after lentils (29.6%; Ministry of Agriculture and Development [MoAD], 2014). Nepali laborers in Sikkim, India, introduced cardamom to Illam district during the 19th century.

The large cardamom plant is a perennial herb with subterranean rhizomes with leafy shoots. Stem is apseudo stemwhich is called tiller. Inflorescence is spike. Generally, 30 to 40 flowers are observed in a spike. Flowers are yellow, bisexual, zygomorphic and pollinated by bumble bees. There are three petals with a labellum which is mainly for attracting insects for pollination. Anthesis occurs in the morning hours. Ovary is inferior with ovules in axile placentation, stigma funnel shaped; fruit is a capsule, achinated, maroon in color with seeds which are whitish in immature stage and dark brown to black in mature stage generally contains moisture 8.5%, protein 6%, volatile oil 2.8%, crude fiber 22%, starch 43.2%, ether extract 5.3% and alcohol extract 7% (Shankaracharya et al., 1990). Additionally, 100gm of large cardamom seeds contains 666.6 mg calcium, 412.5 mg magnesium, 61 mg phosphorous and 14.4 parts per million fluoride (Bhandari et al., 2013)

Cardamom is grown in Nepal between an elevation of 600 to 2000 meterabove sea level where annual rainfall is between 1,500 to 2,500 mm and the temperature varies from 8° C to 20° C. Economic yield starts from 3rd years onward after planting and its optimal yield period is 8-10 years. The total life span of Cardamom plants is about 20-25 years.

For years, Nepal has been recognized as a major producer and exporter of cardamom, second only to Sikkim (Chapagain, Pathak, & Rai, 2014; Durbeck & Torstan, 2010; Partap, Sharma, Gurung, Chhetri, & Sharma, 2014). Exports increased to 5,200 MT of cardamom in 2009 (Stoep, Pokharel, Rajbhandari, & Shrestha, 2010), and in 2012/2013, Nepal became the world's largest cardamom producer, with a total of 5,763 MT of cardamom, worth Rs. 2,528 million or about US$23.6 million, on about 14,847 ha of land in 40 districtsand 15700 ha of land with production of 6439 MT of

Cardamom in 2016-17 (statistical data on Nepalese agriculture 2016-17),with cost benefit ratio of 1:10.

Medicinally, cardamom seeds have diuretic, antidote for snake and scorpion venom, stimulant, stomachic, alexipharmic and astringent properties (Gopal et al., 2012). Cardamom capsules and seeds are used to treat gonorrhea, congestive jaundice, headache, and stomatitis and to control insects (Satyal et al., 2012)

2. METHODOLOGY OF STUDY

Field surveys were conducted in different seasons from July 2016 to March 2017. The farmers namely Tikaram Paudel (cardamom farming in 3.5 ha), Kedar Acharya (cardamom farming in 5 ha of land) (Rangkhani pahi, 6 Baglung) were the integral part of the survey. The areas around was taken by them and helped in recording data of the yield loss of the cardamom. The field visit and observation for the diseases, chirke and foorke were recorded.

The plantation affected by the diseases was recorded in the area 10m*10 m in dimension. The yield of that particular dimension not affected by any diseases was recorded. Finally the yield loss % was calculated and the data are interpreted in table1 and table 2.

Survey Field Located At Rangkhani, Baglung

Author Jiwan During Survey

Table1. *Plant Incidence with Chirke and Foorkey Diseases*

S.No	Location	No. of plantation surveyed	Plants affected by Chirkey disease	Plants affected by Foorkey disease
1	Chisti, Baglung	4	2	7
			1	3
			0	4
			2	0
2	Damek, Baglung	3	3	4
			2	3
			5	7
3	painyu, Baglung	3	1	10
			4	13
			0	7
4	Dhuseni, Baglung	2	2	5
			3	9
5	Rangkhani, Baglung	2	6	8
			2	12

The roman numerals represent the plantation field under survey

Table2. *Yield Loss Due To Chirke and Foorkey Diseases*

Particulars / Area	Average field productivity (10 sq. m area)	Average Productivity of Chirke affected field (10 sq. m area)	Average Productivity of Foorkey affected field (100 Sq. m area)	% yield loss by chirkey disease	% yield loss by foorkey disease

Chisti	4.71 Kg	3.10 Kg	3.00Kg	33.97%	36.30%
Damek	5.58 Kg	2.80 Kg	2.73Kg	49.82%	51.07%
Painyu	5.84 Kg	3.62 Kg	2.60 Kg	38.01%	55.47%
Dhuseni	6.67 Kg	4.25 Kg	3.80 Kg	36.28%	43.02%
Rangkhani	4.92 Kg	2.32Kg	2.70Kg	52.84%	52.84%

Weight above is referred to Dry weight of capsule.

3. CHIRKE DISEASE

3.1. The virus

The virus consists of polyhedral particles measuring 40 nm diameters. It has a thermal inactivation point of 50-600C for 10 min, withstands a dilution up to 1:5000 and the longevity in vitro is about 4-8 days. A new virus species large cardamom chirke virus (LCCV) under the genus Macluravirus, family Potyviridae has been characterized (Mandal et al, 2012).

3.2. Etiology

The 3' terminal genome sequence of the virus associated with chirke disease was revealed and found phylogenetically close to CdMV under the genusMacluravirus, family Potyviridae.

3.3. Symptoms

The symptoms of chirke disease are delineate by streak mosaic on the tender leaves with dark green streaks in the light green background of the lamina. In the severely affected plant, the mosaic streaks coalesce and the leaf gradually turns brown and dries up subsequently.

3.4. Loss Yield

The affected clump produces less number of flowers and thus causes a serious loss in yield. Raychaudhuri and Ganguly (1965) experimentally showed that the loss due to the virus was as high as 85.20% and 80.09%

Fig1. *Chirke disease of large cardamom*

Fig2. *Foorkey disease of large cardamom*

Figure3. *Aphid vector Rophalosiphum maidis Fitch of chirke disease on large cardamom*

Fig4. *Aphid vector (Mollitrichosiphum sp.) of foorey disease*

3.5. Control

0.075% hydroquinonetreatment of rhizomes and soil drenching with 0.1% of thiouracil showed virus inhibition (Raychaudhuri and Ganguly, 1965). Raychaudhuri and Ganguly (1965, 1966) suggested that time to time extirpate of the diseased plants with theirplenishment of certified virus free plants is essential for the management ofchirke disease.

3.6. Foorkey disease of large cardamom

In Nepalese, foorkey means bushy.The virus belongs to the genus Nanovirus and family Nanoviridae (Mandal et al., 2004).

3.7. Transmission

The foorkey is not sap transmissible. Varma and Capoor (1964)reported that at Poona, the foorkey was readily transmitted by the banana aphid,

Pentalonia nigronervosa in a persistent manner. Later, Basu and Ganguly (1968)reported that at Kalimpong, the foorkey was transmitted by another aphid,Mycromyzus kalimpongensis Basu, but not by the banana aphid.

3.8. Etiology

A few isometric particles of 17 to 20 nm were found to be associated with thediseased plants. Mandal and his colleagues (Mandal et al., 2004; Mandal et al.

2007) for the first time reported association of a nanovirus with the foorkeydisease of large cardamom based on the nucleotide sequence of replicationassociated protein gene (Rep), which showed 80-82% identity with BBTV andfrom 47.6% to 48.5% identity with other nano-viruses.

3.9. Symptoms

Pronounced stunting and formation of numerous minute tillers which fail to form inflorescence. The tillers do not grow beyond a few inches in height and appear bushy.

3.10. Yield loss

Varma and Capoor (1964) recorded crop damages ranging from 8.7 to 93.9 percent.

3.11. Control

Foorkey affected plants must be extirpate. Varma and Capoor (1964)showed that injection of a few milliliters of Agrozone-40 into the infectedrhizomes caused withering that facilitated the easy lifting of the clump. Use healthy planting material can control foorkey disease.

The plantation should be regularly sprayed once in three weeks with metasystox to check the movement of aphids.

4. Results and Discussion

Chirke disease spoliation varied from 0.0% to 17.14% and foorkey disease spoliation varied from 0.0 % to 37.14 % in various plantation in Baglung District.

Whereas the yield loss due to Foorkey disease varied from 36.30% in Chisti and 55.47% in Painyu.The yield loss of large cardamom due to chirke disease varied from 33.97% in Chisti to 52.84% in Ran

5. Conclusion

Nepalese cardamom has not good market access in SAARC countries except India. The highest tariff is applying by Bhutan which is 35% followed by Bangladesh which is 23.75%. Nevertheless, world's top importers like UAE, Singapore, India and other are providing 0% tariff to the Nepalese cardamom. (National Sample Census of Agriculture Nepal 2016/17)

A little research has been carried out on clinical studies of bioactive components of large cardamom. Additionally, agro-economic perspectives must be focused on market expansion and market values during large cardamom research and development.

The Loss due to Chirke and Foorkey should be immediately cut down to size in order to ensure the good production of large cardamom.

Nevertheless, having strength and opportunities in cardamom industry in Nepal, some of the uncertainties exist too. Such as decline labor inputs, reoccurrence of diseases and pests, vague price fixation mechanism, incremental use of chemicals and if no international trade, impaired domestic consumption, seriously threatening the cardamom industry, which compelled to higher attention

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