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Short Communication

Occurrence of algal stem blotch in ber (*Ziziphus mauritiana*) under coastal Odisha conditions in India

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ABSTRACT

The investigation was carried out during 2017-18 to identify and document the emerging diseases of Indian Jujube or ber (*Ziziphus mauritiana* Lamk.) in Odisha state located in Eastern part of India. Periodical visit and subsequent investigations revealed the occurrence of a new kind of stem blotch disease in ber caused by alga. Symptoms were observed on bark of the stem and branches as bright red velvety blotch colonies during July- September 2017. However dull grey blotches were visible throughout the year. Leaves and fruits were left unaffected. The algal stem blotch occurrence was assessed during the year 2018 and disease severity ranged from 9.4-14.8 per cent. The green alga was identified and confirmed as *Trentepohlia arborum* (Agardh) Hariot based on key morphological characters. The stem blotches lead to death of young twigs measured between 3 to 8 mm thickness on primary and secondary branches wherein thickness of branches was more than 10 mm, algal blotches caused cracking of bark. Present study highlights the causal agent of stem blotch of ber, its symptomatology, impact of disease and suggested management practices.

Keywords: Ber, Indian jujube, Odisha, Stem blotch, *Trentepohlia arborum*

INTRODUCTION

Indian jujube or ber (*Ziziphus mauritiana* Lamk.) is a spiny small tree belongs to the family *Rhamnaceae* which is native of India (Krishna *et al.,* 2014). It is also called as desert apple, jujube, chinese apple, ber etc. Although *Z. mauritiana* is extensively distributed in tropical areas of the world, India is a major place of its cultivation. In India, it is cultivated over 49,000 ha with the production of 4, 81,000 MT per year (Anon, 2017). Ber fruits are healthy as well as nutritious which contains higher quantity of vitamin C which is much higher than citrus and apple (Khera and Singh, 1976). In the current scenario, improved varieties of ber are gaining recognition among the farmers in many parts of the country because of its adaptability to various climatic condition. In Odisha too, ber cultivation is gaining momentum during recent years and in general climatic condition prevalent in coastal Odisha is different from rest of the country. Hence knowledge on diseases hampering the productivity has to be generated to develop suitable management practices at regional level to make ber cultivation as more remunerative. The diseases like powdery mildew caused by *Oidium erysiphoides* var. *zizyphi* was reported as an economically important disease of ber, which can lead to 50-60 per cent loss in fruit yield (Jamadar and Shamarao, 2004). Other diseases like rust caused by *Phakospora zizyphi-vulgaris* (Gupta *et al.,* 1984), leaf spots and fruits spots (Gupta and Madan, 1977a; 1977b;), witches broom caused by MLOs (Khan *et al.,*2008) and leaf spots caused by *Alternaria, Cercospora, Septoria, Cladosporium, Pestalotiopsis* etc. were reported to infect ber crop in India. A kind of bright orange colour cottony stem blotches of various sizes combined with cracking were observed on bark of one and half year-old ber plants (Fig. 1A) at the experimental orchard of ICAR-IIHR - Central Horticultural Experiment Station situated in the state of Odisha during July - September 2017. In severe cases twig drying also was observed. Based on symptomatology, it was identified as plant parasitic algal infection. Similar kind of symptoms was reported on black berry crop due to plant parasitic algae *Cephaleuros virescens* and the

disease was referred as orange cane blotch (Holcomb *et al*., 1998). It has been documented as one of the important diseases of black berry grown in coastal plains experiencing warm, wet, humid environment in South Eastern United states (Browne *et al*., 2020). Hence systematic study was planned to identify the organism involved in causing stem blotch in ber, its symptomatology, impact of algal parasite on crop growth and prophylactic measures to be undertaken.

The study was carried out at the experimental farm of ICAR-IIHR-Central Horticultural Experiment Station, Odisha during 2017-2018. The experimental farm is located at 20°15' N latitude and 85°15' E longitude with an elevation of 25.5 m above MSL experiencing humid hot, tropical climate which receives average annual rainfall of 1400 mm between June to September. Disease incidence and severity was recorded during 2018 crop season at fortnight interval and required number of plants remained unsprayed for assessing the disease severity. Totally 25 plants were chosen and tagged for diseases assessment and minimum 4 stems per plant was marked with field tape and assessed for stem blotch throughout the year. Severity of algal blotch was assessed visually for the total length of stem/branch using 0-5 arbitrary scale (0- No stem blotches, 1 = trace infection (< 1 per cent of branch covered with algal blotches); 2 = Light (1-5 per cent of branch covered with algal blotches); 3 = Moderate (6–25 per cent of branch covered with algal blotches); 4 = Severe (26-50 per cent of branch covered with algal blotches but no twig drying; 5 = Very severe >50 per cent of branch covered with algal blotches accompanied with twig death). Per cent disease index (PDI) was determined using the formula, PDI=Sum of all disease rating × 100/ (Total no. of rating × maximum disease grade).

Stems (n=10) bearing algal blotch from the different ber trees grown in our experimental orchard was collected during July-September 2017 and symptoms were observed visually as well under a stereomicroscope and macroscopic features of algal thalli were noted. Microscopic features of algal thalli, features of filaments, sporangiophore and sporangia were observed under bright field microscope. Dimensions of algal structures *viz*., were measured (n=30) for each structure and the range of the values were noted and described. Algal parasite was identified based on the descriptions given by Silva *et al*. (2010). and Thomas *et al*. (2019).

Bright orange, circular blotches ranged from 2-30 mm diameter were observed during humid rainy days (Fig 1B). Macroscopic structures of algae were observed under stereo zoom microscope. The orange patches consist of cottony filaments and spore masses of algae. The algal lesions were mostly circular to irregular and were raised, velvety and were often brick-red in colour during rainy months and the rest of the year, the lesions were greyish in colour. Approximately 3 mm to 8mm size thickness twigs as well as branches were severely affected which lead to twig death and branch dieback (Fig 1C) in young twigs. On primary and secondary branches where in thickness of branches was more than 10 mm, algal blotches caused cracking and plant tissue/bark beneath blotch/ algal thalli was

Fig. 1A. Stem blotch disease caused by *T. arborum* on ber, 1B. Close up view of stem blotch symptom, 1C. Drying of young twigs

discoloured, necrotized. The bark cracking was observed from mild to deep from (Fig 2A-2D) and in extreme cases big branches died due to invasion of secondary pathogens.

All the trees in orchard were found infected with mild to severe form and per cent disease severity index were ranged from 9.4-14.8 during 2018 and maximum disease severity was recorded during second fortnight of June 2018. The voucher specimens of ber infected with algal stem blotch was sent to, Lichenology and Algology Laboratory, CSIR- National Botanical research Institute, Lucknow and it was identified as *Trentepohlia arborum* (Agardh) Hariot.

Microscopic features algae were documented by using the Olympus BX 53 microscope. The main plant body of *T. arborum* was thallus that consisted of uniseriate (arranged in single row) poorly branched, entangled filaments, tapered to the apex, branched at 90° angle; individual cells were of cylindrical in shape. Grouped sporangia (ranged from 4-8 in number) from a basal enlarged cell (or suffultory cell) observed to be unique characteristic feature. Sporangia was round to elliptical in shape, present laterally or apically on the erect axes and measuring 16-20 µm in diameter (n=25) (Fig 4A and B). The above algal descriptions are in line with Thomas *et al*. (2019) and Silva *et al*. (2010). Cribb (1958) characterized *T. arborum* by its grouped sporangia from a basal enlarged cell and the tapered filament.

The genus *Trentepohlia* includes about 40 species (Hoek *et al.,* 1995) and this genus mostly exists in tropical climatic area; however, it also exists in temperate areas (Liu *et al.,* 2012). *Trentepohlia* belongs to the phylum *Chlorophyta,* class *Ulvophyceae*, order *Trentepohliales* and family *Trentepohliaceae* (Guiry and Guiry, 2016). In the current scheme of taxonomy, *Trentepholiales* comprise of single family *Trentepohliaceae* with five genera such as *Trentepohlia, Cephaleuros, Phycopeltis, Printzina* and *Stomatochroon* (Brooks *et al*., 2015). Till now in India, the green algae, *Cephaleuros* species is well known for its parasitic nature on several plants and causes orange to reddish spots consists of sporangiophores and sporangia on stems, fruits, leaves of the many ornamental and fruit trees (Pitaloka *et al.,* 2015). Extensive survey carried out in Eastern India to document the diseases of ber by Misra *et al.* (2013) revealed the occurrence of *Cephaleuros* sp. on ber leaves.

Even though wide survey was carried out in India by number of researchers with regard to *Trentepohlia* species, (Bruhl and Biswas, 1923; Randhawa and Venkataraman, 1962; Krishnamurthy, 2000), information of *Trentepohlia* as a plant parasitic algae is limited in India. As early in 1980s, Jose and Chowdary (1980) reported a species of *Trentepohlia dusenii* from Calcutta, India. *T. aroburm* was reported from Kerala and Shillong from rocks (Panikkar and Sindhu, 1993; Kharkongor and Ramanujam, 2015).

Fig. 2A to 2 D. Stages of bark cracking due to *T. arborum* blotches on bark of ber

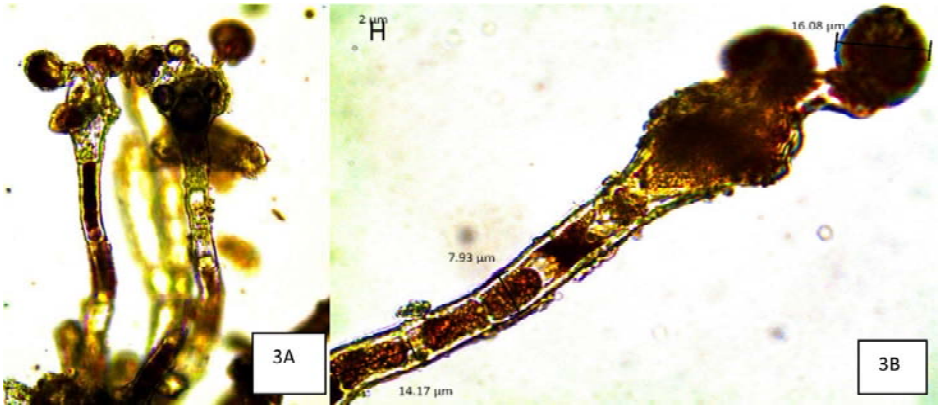

Fig. 3A and 3B. Microphotographs of *T. arborum* infecting ber

*Trentepohlia rigidula*was reported on sub-aerial habitat as greenish coating on cement walls of a temple in Bhubaneswar, Orissa (Samad and Adhikary, 2008). The ecological study of the species indicated the major occurrence of this genus on the substratum like tree bark in the tropical area. *T. rigidula* (J. Muller) Hariot was recorded from West Bengal, India from two distinct habitats (i.e.) epiphytic form on tree bark of bael (*Aegle marmelos*) and epilithic form on a concrete cement tank wall (Satpati and Pal, 2016). In a survey conducted from Indian sundarbans biosphere reserve, four *Trentepohlia* species *viz*., *T. abietina, T. sundarbanensis, T. torulosa* and *T. thevalliensis* were reported (Satpati and Pal, 2015). At Bhitarkanika National Park in Kendrapara district of Odisha, the tree species like *Avicennia alba, Avicennia officinalis, Ceriops decandra, Heritiera fomes, Rhizophora apiculata* etc were found to be the major hosts of *Trentepohlia flava* (Chakraborty *et al*., 2012) and this species were found to colonise the tree bark within the mangroves.

The present study proved the infection of *T. arborum* in *Z. mauritiana* causing stem blotches in ber which resulted in die back of young twigs and cracking of bark portion below the point of infection and has the potential to reduce the vigour of young as well as matured plants if care is not taken at right time. When blotch colony formation *i.e.,* the coverage of the stem/branch by algal blotch is limited without cracks, then this parasitic alga does not limit or have not much adverse effect on crop. But where ideal environmental conditions of warm, wet and humid environment prevail, it girdled the small stems/ branch and also paved the way for secondary infection, causing death of young branches and twigs. Similar kind of observation was made in black berry plants infected with *algae, C. virescens* which was evidenced in terms of orange lesions on stems led to girdling of canes and if favorable conditions continue in the field, algal colonization combined with secondary fungal infections could lead to dieback and death of canes (Brooks, 2004). Black berry canes with larger and more numerous blotches produced significantly lesser number of berries than canes with slight/no algal blotch (Browne *et al.,* 2020).

During the study period, it was observed that algal botch was mainly observed on ber during warm rainy weather coupled with high humidity (data not shown).The prevailing humid climate in coastal plains of Odisha accompanied by frequent rainfall and warm temperature might favoured the algal pathogen and predispose the crop to infection. The earlier studies were also revealed that the members of *Trentepohliales* have been widespread in tropical and temperate regions with humid climates (Chapman, 1984) and recurrent rains coupled with warm weather might encourage the viability of the algal parasite in the host plants (Han *et al.,* 2011; Sunpapao *et al.,* 2016). Southwest monsoon followed by sudden summer encouraged rapid infection of *Cephaleuros diffuses* in leaves of *Artocarpus* in Kerala (Thomas *et al*., 2016).

For the management of as orange cane blotch in black berry canes (woody stems) caused by parasitic algae *C. virescens*, Brannen (2018) recommended the removal of old canes and their destruction promptly after harvest, pruning to improve air movement in the canopy, strategic site drainage, proper weed control, plastic mulching combined with drip irrigation, and application of appropriate agrochemical. The present study witnessed that, from the viable algal lesions present on stem bark, algal inoculum re-emerges and

infect the crop during subsequent year; consequently, if the disease was not effectively controlled during the previous year, the succeeding crop ended up in high level of disease severity. Hence it is suggested that, the plants have to be trained and pruned with open centre system with 2-3 primary branches at a height of 50-60 cm. In addition, pruning has to be done every year to remove weak and diseased branches to obtain healthy tree growth and profitable crop. Under Odisha condition, pruning during February-March (after fruit harvest) followed by spray of copper hydroxide (2.0 g/l)) or copper oxychloride (3.0 g/l) at fortnight interval provided efficient control of stem blotch disease of ber. As the ber cultivation is gaining momentum among the farmers in the state of Odisha, more studies are warranted to know the detailed role of epidemiological factors with regard to stem blotch disease severity especially under coastal Odisha condition.

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