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LETTER TO THE EDITOR

# Measures to Minimize the Growing Menace of Red Rot of Sugarcane in Subtropical India

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**Abstract** Red rot caused by *Colletotrichum falcatum* is the major fungal disease responsible for deteriorating and knocking down major commercial sugarcane varieties out of cultivation during the past 120 years. Recently, a popular commercial variety with very high yield and sucrose content, Co 0238, became victim of red rot due to the emergence of a new virulent pathotype, CF13. This variety occupies > 75% area in Uttar Pradesh, the major sugarcane growing state in India, and because of its breakdown to red rot, both the farmers and millers are facing serious economic losses. In view of the present alarming situation, immediate attention is required to gradually reduce the monocropping of Co 0238 and replace the variety in the command areas of sugar mills of the state, as well as implement scientifically established crop management practices to sustain sugar production in the subtropics. In this communication, some important red rot management practices have been suggested; these may be useful in reducing losses due to red rot epidemics and help in sustaining sugarcane production in north Indian states.

**Keywords** *Colletotrichum falcatum* · Pathogenic virulence · Pathotype CF13 · Red rot management

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In India, sugarcane cultivation is spread over 5.1 M ha area, subtropical belt comprises ~ 2.8 M ha producing over 200 million tons canes (Niti Aayog 2020). Sugarcane productivity and quality in the subtropics are greatly impacted by multiple abiotic and biotic stress. Although there are more than 50 diseases reported in India, red rot of sugarcane is one of the most dreadful disease and is responsible for the elimination of many elite commercial varieties such as Co 312, Co 658, Co 997, Co 1148, Co 6304, CoC 671, CoC 8001, CoC 85061, CoC 86062, CoC 90063, CoC 92061, CoJ 64, CoSe 92423, and CoS 8436 in the past (Viswanathan 2018; Viswanathan and Rao 2011). The present sugar industry in the subtropics is facing serious problems due to sudden outbreak of red rot. The popular variety Co 0238 (parentage CoLk 8102 × Co 775) was released for commercial cultivation during 2009 and due to its higher yield and sucrose content, both growers and millers patronized this variety. The average cane yield of > 80 t/ha as against 68 t/ha of the check variety CoJ 64 has a motivating influence on the farmers, whereas its high sucrose content, i.e., 18% in juice by 300 days and its steady increase to > 20% during March–April (against 17.9% in the check variety CoJ 64) fascinated the sugar mills to indiscriminately expand Co 0238 in their command areas. In the state of Uttar Pradesh, this variety was grown in only 3.1% area in 2013–2014, due to its all-round economic impact on growers and industry, the area steadily

increased to more than 10 times in 2016–2017 (Ram and Hemaprabha 2020) and further increased to a near monopoly of a single variety now. In 2019–2020 season, Co 0238 had occupied 2.2 million ha in Uttar Pradesh, this was approximately 82.21% of the total sugarcane area in the state. In subtropical states, this wonder variety was in cultivation on an area of 2.58 Mha in Punjab, Haryana, UP, Uttarakhand and Bihar, which is 79.2% of the sugarcane area in these five states during 2019–2020 season. At all India level, the percentage of area covered by Co 0238 is around 53.2%, which is the highest percentage ever covered by a single variety. Besides five subtropical states, Co 0238 has also occupied a sizable area in Gujarat, Madhya Pradesh, and Odisha (Ram 2020). The increase in both sugar recovery and cane yield has led to tremendous increase in sugar production by many sugar mills of north India. The variety has benefited the industry with the record sugar recovery exceeding 12.0%. In 2019-2020 season, a few sugar mills in Uttar Pradesh have recorded more than 13% sugar recovery, highest ever in the subtropical India (Ram 2020).

The red rot of sugarcane is spreading fast and increasing incidences are reported from many sugar mill areas of Central and Eastern Uttar Pradesh and Bihar, especially in the predominant cv Co 0238 during the recent years (Fig. 1). Surveys carried out by the scientists of ICAR-IISR, Lucknow, UPCSR, Shahjahnapur and ICAR-SBI have revealed that breakdown of varietal resistance against red rot is due to the origin of a new virulent pathotype in cv Co 0238 (Viswanathan et al. 2020). The highly virulent pathotype specifically causes susceptible reaction on the cv Co 0238 and is recently designated as a new pathotype CF13 (Viswanathan, personal communication).

In view of the prevailing situation, the following crop protection measures may become imperative to sustain the field stability of Co 0238 and reduce losses due to red rot pathogen:

- Efficient management of red rot can be achieved through host resistance and it is the most sustainable and also cost-effective approach (Viswanathan 2021a). Hence, wherever complete crop losses are noticed in Co 0238, the variety has to be replaced with other recommended varieties. Promising red rot resistant varieties Co 98014, Co 0118, UP 05125, CoS 08272, CoS 08279, CoS 13231, CoLk 94184, CoLk 11203, CoLk 14201, and CoSe 13235 notified by CVRC may be multiplied in large quantities through single bud or chip bud nurseries for planting in severe red rot affected places.
- All the recommended agronomic practices such as use of healthy planting materials, certified seeds, field sanitation, crop rotation, green manuring, provision of proper drainage facility, and bunding of infected fields should be practiced to reduce disease severity. Further, these cultural practices/IDM are being suggested not only to reduce the inoculum in the field, but to also reduce crop losses (Viswanathan 2012, 2021b).
- Strict enforcement of a nursery program is essential to prevent spread of the disease through seed canes. Hence, in disease endemic areas, availability of seed material free from diseases, pests, and mixtures of other varieties must be ensured. To meet the huge demand for seed canes, the farmers are also advised to have seed cane nurseries and this will prevent disease introduction through unknown seed sources.


**Fig. 1** Severe destruction of sugarcane crop due to red rot (cv Co 0238) in Eastern Uttar Pradesh. **a** Waterlogged areas exhibit total crop losses due to disease severity; **b** The apparently healthy sugarcane also shows red rot in entire canes ( *Source*: Dr Y.P. Bharati, GSSBRI, Seorahi, UP)

- To raise quality seed, single bud setts from healthy canes should be planted after treating the canes using moist hot air (54 °C for 2½ hours and 95–99% RH) (Satyavir 2003) or by hot water treatment (52 °C for 2 h) and subsequent generations should be raised with inspection. To have improved efficacy, systemic fungicides (Thiophanate Methyl (0.1%) can be mixed with hot water, this may kill the deep seated fungal infections, if any. The duration of hot water + fungicide treatment can be reduced to 1 h. It has been documented that sett borne infections of *C. falcatum* can be suppressed by heat therapy, however, its efficacy depends on various factors including level of infections (Viswanathan 2021b). Heat treatment is a protective measure in disease management and it does not prevent infections from soil or water. Hence, other agronomical practices are essential to manage the disease under field conditions.
- Alternatively, a new mechanized sett treatment method has been developed by ICAR-SBI, Coimbatore, which is quite effective. In this method, setts are treated in a Sett Treatment Device for 20 min with Thiophanate Methyl (0.1%) and has been found effective to eradicate sett borne infections of red rot. This treatment also prevents entry of soil borne inoculum in causing red rot in the planted setts and young crops, till 90 days. The sett treatment device facilitates effective diffusion of fungicides inside the setts and manages red rot in sugarcane (Malathi et al. 2017; Viswanathan et al. 2016). Effective protection of young crops through efficient sett treatment prevents disease builds up in the field.
- Red rot of sugarcane could be biologically managed through *Trichoderma* spp or bacterial antagonists. These bio-agents possess the ability to protect the crop from soil borne inoculum of red rot (Joshi et al. 2019; Viswanathan and Malathi 2019). Application of *Trichoderma* (20 kg/ha) mixed with 200 kg of sterilized decomposed press mud/FYM at the time of planting suppresses the soil borne inoculum of *C. falcatum* and induces systemic resistance against the pathogen. In commercially available formulations, an antagonist count of $> 2 \times 10^8$ CFU/g is desirable to have better response. The genuine products and microbial culture can be obtained from ICAR-SBI, Coimbatore, ICAR-IISR, Lucknow and other reputed institutions. It is to be noted that bio-control agents do not provide any curative effect, hence these have to be applied before planting and repeated applications are recommended to enrich rhizosphere with antagonists; also, if the inoculum pressure of the pathogen is very high, we should start with fungicides and bring-in bio-agents once the disease severity is considerably reduced. Quality of bio-formulation is to be ensured for success of this approach.
- If the disease infection is persisting/expected to persist, the fungicide Thiophanate Methyl (0.1%) may be applied as foliar spray (at 3–4 months stage) or may be delivered through micro-irrigation if the system is installed in the field.
- In ratoon crop, two sprays of Thiophanate Methyl (0.1%) may be given; the first one, immediately after ratoon sprouting (30 days) and the second during 60–90 days to prevent disease build up in the field in endemic locations. This recommendation may be followed even if disease incidence is not noticed in disease endemic locations.
- Red rot affected fields may be avoided for fresh sugarcane planting and such fields may be brought under crop rotation with other crops to reduce red rot inoculum surviving in soil.
- Since seed contains the inoculum, seed movement among the farmers should be restricted in the command area. Regulation of seed movement should be strictly monitored by state authorities and sugar mills.

The monocropping with a single variety in the command area has contributed significantly to the emergence of a highly virulent pathotype. Uttar Pradesh state has witnessed historical failures of ruling varieties such as Co 213, Co 312, Co 313, Co 421, Co 453, Co 513, Co 1148, and BO 11 during the past decades. All these failures were attributed to varietal breakdown and emergence of virulent pathotypes. Monocropping of these varieties was responsible for large-scale destruction of the crop and this phenomenon is referred as 'boom' and 'bust' cycle (Viswanathan 2021a). Hence, in future also, for sustainable sugarcane cultivation, no variety should be grown in more than 50% in a mill area. Though there are huge benefits accrued to the farmers and industry by adopting the cv Co 0238 in the past few seasons (Ram 2020), the current damages to cane cultivation in thousands of hectares in the state outweigh the accrued benefits. Further, gained virulence of the pathogen is another serious blow for successful cane cultivation since the new virulent pathotype will erode red rot resistance in the new varieties.

The management practices suggested above will help in containing the widespread incidence of this new virulent red rot pathotype and its associated damages. Immaculate planning with major focus on the selection of resistant varieties, area under each variety, IDM, and selective crop protection strategies by each sugar mill is the need of the hour. A comprehensive effort is therefore required by the farmers, mill management staff and scientists to protect the largest sugar industry network in the subtropical India.

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**Declarations**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Human Participants and/or Animals** The present research did not involve human participants and/or animals.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

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