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# Management of Sugarcane Smut Caused by *Sporisorium scitamineum*: A Review

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**ABSTRACT**
*Sugarcane smut is one of the most dreaded diseases of sugarcane. This disease is also known as culmicolous smut which describes the outgrowth of fungus of the stalk on the cane. The disease is cosmopolitan in distribution and has been become significant in all sugarcane producing countries in the world. It attacks several sugarcane species and has been reported to occur on a few other grass species but not to a critical amount. Primary infection starts from infected sugarcane setts while secondry spread from windborne teliospores present in whip like structure. Whip releases significant proportions of spores i.e 1x $10^8$ to 1x $10^9$ teliospores per day for approximately three months so management of smut disease is very important. Single control method applied so far for smut management is inadequate so integration of physical, cultural, chemical, biological control, host resistance and quarantine regulations are essential for efficient, effective and eco-friendly management of smut of sugarcane.*
***Keywords:*** *Smut, Sugarcane, Hot water treatment, Fungicides, Bio-agent, Resistance*

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## INTRODUCTION

Sugarcane (*Saccharum* spp), a long duration crop cultivated in tropical and sub tropical regions of the world. According to Directorate of Economics and Statistics [1] sugarcane is cultivated in total area of 5.14 million hac with 359.33 million tonnes production and 69.86 tonnes/ha productivity in India. It is considered as highly valuable cash crop, because of its ability to store high concentration of sucrose or sugar in the stem. Now a days, it is used for the production of ethanol which is an important renewable bio-fuel source. Sugarcane is also considered as second most important agro industrial crop in India next only after cotton. There are several factors which reduce sugarcane yield as well as affect cane quality and one such cause for concern is the impact of diseases. Because of its vegetative mode of propagation, sugarcane is prone to infection by systemic pathogen among which smut is the most important disease and major constraints in the profitable cultivation of sugarcane.

Earlier the smut pathogen was unknown but in 1930's it caused severe problem in our country. After that it became widespread in most of the sugarcane growing states of our country. In India, this disease is distributed in many states viz., Andra Pradesh, Bihar, Delhi, Gujarat, Punjab, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal. Smut of sugarcane is caused by a dimorphic basidiomycete fungus *Sporisorium scitamineum* Sydow [M. Piepenbr., M. Stoll & Oberw. 2002 (Syn: *Ustilago scitamiea* H. & P. Sydow)] which incites considerable losses in sugarcane yield and quality in almost all cane growing countries of the world.

For effective management of smut disease, effort should be made to reduce initial inoculum as well as to slow down the progress of disease. Hence the management approach should be focused both on preventive or prophylactic as well as reducing infection rate which may be achieved by the use of different components including physical control, cultural adjustments, need based use of fungicide, biological control, host resistance and quarantine regulations.

### 1. Disease symptoms

After germination, disease can be observed in all the crop stages. The most diagnostic feature of this disease is development of whip like structure from apical meristem of the stalk. The size of whip differs in

size and may be few centimetre long to 1.5 meter sometimes extending high above the crop canopy. It consists black powdery mass which is covered by white, thin membrane. On maturity, the membrane gets disintegrate and release millions of wind borne teliospores. Affected plant gives spindly and more erect shoot with small as well as narrow leaves.

**2. The pathogen**

Smut pathogen was first noticed by Sydow and Butler in the year 1906 in our country. Few years later in 1924, Sydow studied and named smut fungus as *Ustilago scitaminea*. Piepenbring *et al*. [2] rearranged the position of sugarcane smut fungus and named it as *Sporisorium scitamineum*. Smut pathogen belongs to Kingdom: Fungi, Phylum: Basidiomycota, Class: Ustilaginomycetes, Order: Ustilaginales, Family: Ustilaginaceae, Genus: *Sporisorium* (syn: *Ustilago*), Species: *scitamineum*. The fungus has no alternate hosts.

**3. Epidemiology**

Nodal buds of infected sugarcane setts are responsible for primary infection where fungus lies in dormant stage. After the whip emergence, secondry spread of disease takes place and wind borne teliospores affect the nodal buds of standing cane. Under moist condition, teliospores germinate and give rise to promycelium. After that, they undergo for meiosis process and due to bipolar nature, two different mating types of four sporidia develops. During infection process, two sporidia of different matting type fuse and form a dikaryon. This dikaryon produces hyphae which penetrate the basal portion of bud scales of the sugarcane plant and infect the meristematic tissue.

**4. Favourable conditions for disease development**

The disease is favoured by high temperature i.e. $30^0$ C to $35^0$ C and moderate rains. Mehra and Sahu [3] reported that disease development was rapid at above 34.8º C temperature and slow down at $11.5^0$ C to $22.2^0$ C temperature. Hot dry weather always favour the disease development, even plant stress enhance the frequency of whip development. High rainfall reduces the disease severity. Ratoon crops are more prone to smut. The dignostic symptoms of disease first appear during May-June and second during October-November.

**DISEASE MANAGEMENT**

Abera *et al*. [4] and Firehun *et al*. [5] observed that integration of different management strategies such as continued monitoring, rouging of smut affected stools, hot water treatment of sugarcane setts, chemical treatment of setts, use of resistant varieties and avoidance of ratooning of affected fields etc is always helpful to manage the smut disease. If control measures are taken at an early stage of disease development, smut disease can be manage easily and most effectively. It is well known that any of these single control method will not be adequate, so integration of all the management strategy will always helpful for smut management.

**1. Physical control**

Ferriera and Comstock [6] reported that to obtain disease free planting material, seeds are subjected to hot water treatment or heat treatment. Seed treatment with hot water give the good control. Abera [7] also reported sugarcane seed exposed at temperature $50^0$ C for 2 hours and $52^0$ C for 30 minute gave effective management of disease. Proper combination of temperature and time is prime requirement to cure the disease but there is chances of re-infection from spores in the soil due to softening of bud during hot water treatment. To avoid this problem, fungicide can be added which protects the cane from re-infection. Abera *et al*. [4] reported that hot water treatment should be restricted to initial seed cane nursery.

**2. Cultural control**

The cultural control includes the use of disease free seed, rouging of diseased stools, avoidance of ratooning infected fields, fallowing of heavily infected fields. Kalaimani and Natarajan [8] reported that removal of smutted-stools as soon as they appear in cane fields has advantage that it prevents disease spread and further perpetuation of the pathogen. Abera *et al*. [4] observed that removal of smutted-stools or shoots at 10 and 15 days interval from about two months until the crop reaches inaccessible stage is very effective. Akalach and Touil [9] reported that generally smut incidence reaches at it maximum during dry season in which rapid shedding of spores from whip occurs so rouging should be done after whip emergence during this period which can effectively reduce the disease.

**3. Chemical control**

Smut disease is a dreadful disease of sugarcane and is endemic in most of the tropical regions. Bharathi [10] observed that sett dip with fungicide triademifon @ 0.1% or propiconazole @ 0.1% for 2 h can be recommended for an effective management of sett transmitted sugarcane smut and sett treatment with fungicide did not exhibit any influence on germination and shoot production.

Sundravadana *et al.* [11] reported that triademifon @ 0.1 % and propiconazole @ 0.1 % significantly reduced the smut incidence and improved the cane yield. Meena and Ramyabharathi [12] concluded that sett treatment and foliar spray of fungicide triadimefon @ 0.1 % at 30, 45 and 60 days after planting recorded the highest cane yield and the lowest smut infection. Shailbala *et al*. [13] also observed that triademifon @ 0.1 % and propiconazole @ 0.1% as a promising potential against smut disease and reduced disease significantly as well as stress of pathogen on sugarcane crop.. Singh *et al*. [14] reported that tilt @ 0.2 % and emisan @ 0.25 % gave best results for control of sugarcane smut. Bhuiyan *et al*. [15] concluded that fungicide flutrifol mixed with fertilizer @ 100-400 a.i./ha reduced smut infection in sugarcane.

**4. Biological control**

Lal *et al*. [16] gave information that fungal bio-agents like *Trichoderma* spp, *Aspergillus* spp, *Penicillium* spp etc have been found antagonistic to pathogen *Sprisorium scitamineum* and it was also reported by various workers. Shailbala *et al*. [17] reported that bio-agent *Trichoderma harzianum* also proved its potential in lowering down the smut incidence. Singh *et al*. [14] tested bio-agents *Trichoderma harzianum* and *Trichoderma viride invitro* against smut disease and revealed that *Trichoderma viride* gave the better results than *Trichoderma harzianum*. Lal *et al*. [18] observed that 5 % culture filtrate of *Trichoderma viride* inhibited mycelial growth and teliospore germination of smut fungus.

**5. Host resistance**

**Comstock [19]** mentioned that sugarcane smut can be managed effectively through the propagation of resistant varieties. Many smut resistant varieties were developed but due to emergence of new and virulent pathotype, the disease resistance break down. So it is very important to know the smut resistance in sugarcane to flourish the released varieties for commercial cultivation. Ramesh Sundar *et al*. [20] concluded that it is essential to have proper knowledge of host resistance for the successful management of smut disease. Legaz *et al*. [21] reported that β 1, 3 glucanase, chitinase and some glycoproteins produced from sugarcane inhibit the teliospore germination of smut fungus. Santiago *et al*. [22] reported that a possible phytotoxin i.e. caffeic acid also affect the sugarcane as well as fungal growth and physiology.

Some molecular techniques including cDNA-AFLP, differential display techniques etc became helpful to accumulate information on differentially expressed transcripts of sugarcane against smut pathogen. **Esh *et al*. [23]** showed that there were variation in the level of pathogenesis related proteins i.e. poly phenol oxidases, phenylalanine ammonia lyase, peroxidase, esterase, chitinase and β 1, 3 glucanase in sugarcane genotype/clones which are resistant and susceptible to smut fungus**. Su *et al*. [24]** studied structural properties of chitinase gene obtained from RNA Sequence analysis of interaction between sugarcane and *Sporisorium scitamineum*.

**6. Quarantine** In India, sugarcane seed is frequently taken from one state to another state without any regulatory restrictions measures. However, such measures are adopted during routine exchange of sugarcane varieties between the countries. The indiscriminate move of infected cane not only facilitates introduction of dreaded pathogen and their races but also insects and obnoxious weeds into a new area. Jaroenthai *et al*. [25] reported that nearly 20 % of germplasm collections maintained at Thailand recorded smut incidence which has resulted in the reduction of yield and brix by 8-18 % and 17-43 % respectively. In most sugarcane growing countries of the world, strict quarantine regulations govern the importation of vegetative propagation materials of sugarcane or true seed. Most of these countries require proof of hot water treatment of the stalk pieces followed by treatment with a fungicide. This is to ensure that a number of bacterial, viral and fungal diseases including *Sporisorium scitamineum*, will not be brought in. Important regulations are sometimes implemented by governments which help to prevent the spread of the disease. Quarantines are also implemented in areas that are infected. Watson [26] reported that the disease has been well managed by intensive application of field control measures, when the varieties grown are not highly susceptible .

**CONCLUSION**

- Sugarcane is most devastating disease and continues to be a threat in all the sugarcane growing countries.
- The disease is known as culmicolous smut, which describes the outgrowth of fungus of the stalk on the cane.
- Hot water treatment of seed setts is good option for smut management.
- Some recommended practices like seed selection, fallowing of infected fields as well as rouging of infected clumps is the best way to lower down the inoculum levels.
- Sugarcane setts treatment with fungicides and bio-agents is important way to manage seed borne inoculum.

- Resistance to sugarcane smut is the best course of action for management.
- Quarantine regulations for restricting transport of sugarcane setts from infected zone to disease free zone lower down the spread of disease.
- Integrated disease management is always considered as a viable option for disease management, one cannot soley rely on one control method.

**FUTURE THRUST**

- Need to develop more advance techniques for population studies.
- Need to characterize the pathogen population with more robust molecular markers.
- To study the epidemiology of isolates grouped in different categories on the basis of markers.
- Disease resistant varieties should be developed keeping in view the changes in the pathogen population.
- Need to focus more and more on biotechnological aspects for development of resistant varieties.
- More efforts should be devoted for the development of new formulations of bio-agents which can supply nutrient and protection when applied to either the host or other environment where the pathogen is surviving.
- Need to develop such effective integrated disease management strategies which must be adopted by all the farmers, producers, workers, researcher etc.
- Need to develop efficient decision support system for smut disease forecast

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