**Studies on Sugarcane Wilt Caused by *Fusarium sacchari* under Sub-tropical India**

**ABSTRACT**

Wilt disease of sugarcane is a complex and serious disease known to cause significant loss. Wilt of sugarcane was recorded almost 100 years ago in India and is one of the major fungal diseases affecting cane productivity and production. First reported in 1906 by Butler from Bihar and the detailed studies were made a few years later by Butler and Khan in the year 1913. The present study includes genotypes/varieties evaluation against wilt disease (*Fusarium sacchari*) of sugarcane in sub-tropical region of India. Some total of 35 genotypes, maintained at ICAR-IISR, Lucknow and were tested against wilt of sugarcane. Out of 35 genotypes, 25 genotypes were rated as resistant (R) genotypes to wilt disease and 10 genotypes were rated as susceptible (S) against wilt disease of sugarcane. The genotypes rated resistant against wilt disease of sugarcane can be exploited for development of wilt resistant variety of sugarcane whereas rated susceptible genotypes can be exploited as susceptible check for screening against wilt of sugarcane.

**Keywords:** Sugarcane, *Fusarium sacchari*, Pathogen variability, Wilt.

**INTRODUCTION**

Sugarcane *(Saccharum officinarum)*occupies a commanding position as an agro-industrial crop in the country. The crop is cultivated in tropical and sub-tropical in 5 million ha area [1]. The crop engages 123.4 lakh farmers and farm workers [1]. Sugarcane contributes nearly 70% of world sugar production and provides raw materials for many other by-products. Covering about 26.34 million hectares, it produces around 1,859.39 million tons annually [2]. India, the second-largest producer, cultivates sugarcane on 5.15 million hectares, yielding 405.39 million tons per year [3].

Sugarcane is long duration vegetative propagated crop and is being attacked by a number of pathogens (Fungi, Bacteria, Phytoplasma and Viruses). On an average the loss caused in sugarcane by fungal diseases alone ranges from 15 to 30 % [4,5]. (But in case of epiphytotic conditions the losses in yield and sugar goes up to 100 % [6]. The fungal diseases are comparatively more damaging than others.

Among the disease of the sugarcane, wilt disease has also received the attention recently by the researchers working on sugarcane. Butler and Khan [7] for the first time described the disease in India in sugarcane under the term ‘wilt’ and noted *Cephalosporium sacchari* as the causal agent. Wilt epidemics in India during the last century resulted in elimination of many commercial cultivars from cultivation [8,9]. Serological characterization has been made by the several workers across the world but the information at molecular level is scanty. Limited reported has been made by the workers especially in India [10]. The disease is still spreading in various sugarcane producing areas of the world and now a days it is being judged and counted as the second major disease of sugarcane in India [11]. Internationally, the disease has been reported from 34 countries including Bangladesh, Philippines, South Africa, West Indies, USA, Pakistan and Mexico [12].According to Viswanathan [13], any field under harvest displayed 10-15% of dried canes and approximately 50% of them were affected due to wilt.

Country-wide disease assessment revealed that wilt of 60% on Co 7717, 5-10% in CoJ 64, CoJ 79 and CoS 767 in Uttar Pradesh, severe wilt incidence in combination with red rot noticed on major varieties in Bihar, severe wilt incidence on Co 89003 and moderate wilt on Co 7717, CoS 8436 and CoS 88230 in Punjab, varying levels of wilt in most of the varieties in cultivation in South Gujarat, mild wilt on popular varieties in Maharashtra and in Madhya Pradesh [14]. Previous studies of Viswanathan et al. [15] revealed that the disease intensity vary from trace to 75% in different states of India. Wilt in the cv. Co 7805, an elite variety in coastal Andhra Pradesh caused enormous loss to sugarcane production in the past two decades [16].

**MATERIALS AND METHODS**

**Isolation of wilt Pathogen**

Wilt samples were collected from experimental farm of ICAR-Indian Institute of Sugarcane Research, Lucknow. Diseased canes were collected and the infected parts of the tissues were cut into small pieces, and washed in sterile distilled water followed by 70 % ethanol. The bits were then surface sterilized in 0.1 % HgCl2 for 10 s and then rewashed with sterile distilled water to remove HgCl2. The bits were transferred to Potato Dextrose Agar (PDA)/ oat meal agar (OMA) media petri plates. These petri plates were incubated in sterilized condition at 27̊C for 6-7 days. [17].

**Evaluation of Different Genotypes/ Varieties**

To assess the pathogenic variability, the fungal isolates were multiplied on potato dextrose agar medium till 7 days. From seven day old cultures, spore suspension of *F. sacchari* was prepared and utilized for inoculation onto 35 sugarcane genotypes by plug method [18].

**Table:1 Disease rating scale for wilt disease of sugarcane**

|  |  |
| --- | --- |
| **Grade** | **Characteristics of key wilt associated parameters in sugarcane** |
| **Pith cavities in the internodes above the point of inoculation (0,1,2,3)** | |
| 0 | No apparent pith cavities |
| 1 | Moderate pith cavities occupying entire pith region |
| 2 | Cavities along with tissue discoloration covering 2/3rdof the internode width |
| 3 | Entire internodes are converted into deep pith cavities |
| **Nodal transgression above inoculated internode (0,1,2,3)** | |
| 0 | No disease progress in the internodes above the inoculated internode |
| 1 | Moderate pith cavities in at least 2 internodes above with moderate tissue discoloration or vascular streaks |
| 2 | Moderate to severe cavity formation along with tissue discolorations at least in 4 internodes above |
| 3 | Severe cavity formation along with tissue discolorations in more than 4 internodes |
| **Nodal transgression below inoculated internode (0,1)** | |
| 0 | No disease progress below the inoculated internodes |
| 1 | Moderate to severe cavity formation along with tissue discoloration |
| **Top dried / green (0,1)** | |
| 0 | Spindle leaves remain green at the time of examination |
| 1 | The spindle leaves show paleness, yellowing, drying or complete death |
| **Stalk external appearance (0,1)** | |
| 0 | Appears healthy |
| 1 | Rind discoloration, total shrinkage of cane/ drying or death of the inoculated canes |

**Radial growth of isolates**

Wilt isolates were cultured on OMA plates to study the radial growth. Ten isolates of wilt pathogen were used for the study. 5 mm disc of 7 days old culture of wilt pathogen were placed in the middle of the Petri plate containing OMA media and incubated at temperatures of 27ºC. The colony diameter of the fungus was recorded after 24 h, 48 h, 72h, 96h, 120h, and 144h of time interval.

**Morphological Characterization of *Fusarium sacchari***

Morphological study of the isolates of wilt pathogen was conducted to find out the size and shape of the spore. The sugarcane wilt pathogen *Fusarium sacchari* was characterized through lacto phenol cotton blue wet mount and examined under compound microscope at 40x. The fungal morphological characters like spores shape, spores size (length and width) were also studied [17].

**RESULTS AND DISCUSSION**

**Evaluation of Different Genotypes/ Varieties**

The result revealed that out of 35genotypes tested against wilt of sugarcane, 25genotype *viz.,* LG19006, LG19100, LG19097, LG19136, LG19105, LG19104, LG19049, LG19096, LG19171, LG19005, LG19063, LG19109, LG19103, LG19025, LG19039, LG19033, LG19158, LG19017, LG19107, LG19066, LG19087, LG19142, LG19037, LG19101, CoLk17204 were rated as resistant (R) genotypes against the wilt disease. Whereas, ten (10)genotypes *viz.,* LG 19043, LG 19015, LG 19003, LG 19123, LG 19165, LG 19036,Co 17018, CoPb17215, CoS17236, and Co19016 were rated as susceptible (S) against wilt disease of sugarcane. The genotypes rated resistant against wilt of sugarcane can be exploited for development of wilt resistant variety of sugarcane whereas rated highly susceptible genotypes can be exploited as susceptible check for screening against wilt of sugarcane. Viswanthan et al., [19] clearly established that the plug method of inoculation with spore suspension is ideal in inducing wilt compared to the soil inoculum in endemic soils. Thus in the present investigation, plug method of inoculation was used for the disease production. Similar studies were conducted by Viswanathan et al., [20] and Sekhar, [21].

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**Figure 1: Cane showing symptoms of wilt disease**

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**Figure 2: Canes showing cavity formation due wilt disease**

**Radial growth rate of *Fusarium sacchari* isolates**

Out of ten isolates tested against *Fusarium sacchari* (wilt of sugarcane), LG 19043 was recorded the fastest growing rate at 24 hours attaining 1.2 cm diameter. Whereas, Co 19016 recorded the slowest isolate attaining 0.6 cm colony diameter at the same duration. The experimental results revealed that there is variability within the isolates. Overall CoS 17236 isolate of *Fusarium sacchari* rates the fastest growing isolate attaining 1.1 cm, 2.3 cm, 3.2 cm, 4.1 cm and 4.5 cm redial growth at 24h, 48h, 72h, 96h and 120h respectively. The isolate LG 19043 also noted the fast growing recorded 1.2 cm, 2.3 cm, 3.3 cm, 4.1 cm and 4.5 cm redial growth at 24h, 48h, 72h, 96h and 120h time intervals, respectively. Viswanathan et al.,[22] have clustered *F. sacchari* isolates into 7 groups based on variability observed against growth rate of the wilt pathogen. The cultural character such as average growth rate was considered to assess the variability of twelve isolates and the results depicted an average growth rate of the fungus ranging from 6.2 to 7.3 cm on seventh day [21].

**Table 2: Radial growth rate of different *Fusarium sacchari* isolates**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Isolates Variety** | **Radial growth (cm)** | | | | | |
| **24 h** | **48 h** | **72 h** | **96 h** | **120 h** | **144 h** |
| 1. | Co 19016 | 0.6 | 1.2 | 2.2 | 3.5 | 4.0 | 4.5(F) |
| 2. | CoS 17236 | 1.1 | 2.3 | 3.2 | 4.1 | 4.5(F) | - |
| 3. | CoPb 17215 | 0.9 | 1.5 | 2.4 | 3.6 | 4.4(F) | - |
| 4. | Co 17018 | 1.0 | 2.5 | 3.1 | 3.9 | 4.5(F) | - |
| 5. | LG 19123 | 0.9 | 2.2 | 3.0 | 3.8 | 4.4(F) | - |
| 6. | LG 19165 | 1.0 | 2.3 | 3.0 | 3.9 | 4.5(F) | - |
| 7. | LG 19036 | 1.1 | 2.2 | 3.1 | 3.9 | 4.3(F) | - |
| 8. | LG 19003 | 0.9 | 1.7 | 2.8 | 3.7 | 4.1 | 4.5(F) |
| 9. | LG 19043 | 1.2 | 2.3 | 3.3 | 4.1 | 4.5(F) | - |
| 10. | LG 19015 | 0.8 | 1.7 | 2.8 | 3.6 | 4.1 | 4.5(F) |

**Morphological Characterization of *Fusarium sacchari***

Maximum spore length of 18.58μm was recorded with Co19016 isolate of wilt followed by 17.38μm with CoS 17236, 16.33µm with LG 19015, 15.38μm with CoPb 17215, 15.41µm with LG 19036, 14.37µm with LG 19003,14.35µm LG 19165, 13.22μm with LG 19123, 13.31μm with Co17018, and 12.18μm with LG 19043. Whereas, *Fusarium sacchari* spore width measurement studies resulted that maximum spore width of 7.45 μm was recorded with two isolates Co19016 and LG19036, followed by 7.42µm with LG19015, 6.43µm with CoS 17236, 5.44μm with CoPb 17215, 5.43µm with LG19165, 5.40µm with LG19003, 4.42 µm with isolates Co17018 and LG19123, and minimum spore width of 3.38μm was recorded with LG 19043. In 2013 Viswanahtan et al., [22] have performed an extensive morphological study of the wilt pathogen. Similar kind of study was conducted by Sekhar, [21] for the study morphological characters the isolates like size, shape, colour and septation.

**Table 3: Morphological Characterization of *Fusarium sacchari* of wilt conidiospore**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **Isolate Variety** | **Shape** | **Spore length (μm)** | **Spore width (μm)** |
| 1. | Co 19016 | Sickle | 18.58 | 7.45 |
| 2. | CoS 17236 | Sickle | 17.38 | 6.43 |
| 3. | CoPb 17215 | Sickle | 15.38 | 5.44 |
| 4. | Co 17018 | Sickle | 13.31 | 4.42 |
| 5. | LG 19123 | Sickle | 13.22 | 4.42 |
| 6. | LG 19165 | Sickle | 14.35 | 5.43 |
| 7. | LG 19036 | Sickle | 15.41 | 7.45 |
| 8. | LG 19003 | Sickle | 14.37 | 5.40 |
| 9. | LG 19043 | Sickle | 12.18 | 3.38 |
| 10. | LG 19015 | Sickle | 16.33 | 7.42 |

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| --- | --- |
|  |  |

**Figure 3: Photographs depicting cultural characters of wilt pathogen**

**CONCLUSION**

The genotypes/varieties rated resistant against wilt disease of sugarcane can be exploited for the development of wilt resistant variety of sugarcane whereas genotypes/varieties rated susceptible genotypes can be exploited as susceptible check for screening against wilt disease of sugarcane. And the development of resistant varieties is the eco-friendly way to control the wilt disease of sugarcane.

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