

## Original Research Article

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## Impact of Different Dates of Inoculation and Evaluation of Sugarcane Varieties against Red Rot Disease of Sugarcane

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### A B S T R A C T

Sugarcane (*Saccharum officinarum* L.) is an important cash crop grown in tropical and sub-tropical regions of India but the productivity of sugarcane is low as compare to other cane growing countries of the world due to several biotic and abiotic factors. Among the biotic factors, red rot disease of sugarcane caused by *Colletotrichum falcatum* is serious fungal disease affecting sugarcane stalks, the most economical part of the sugarcane. To find out the impact of different dates of inoculation and evaluation of sugarcane varieties against red rot disease of sugarcane, an experiment was carried out at Pusa farm, Sugarcane Research Institute, RPCAU, Pusa during the crop season of 2018-19. The suitable time of inoculation was tested, starting from 26<sup>th</sup> July at ten days intervals, the infection was maximum (8.4, 8.2, 7.8) in variety (CoSe 95422, CoS 8436 and CoSe 92423) respectively, when the inoculations were carried out in the last week of August (25<sup>th</sup> August) whereas, the least infection 5.2, 5.2 and 5.0 was recorded in variety CoSe 95422, CoS 8436 and CoSe 92423 respectively, when the canes were inoculated in last week of July (26<sup>th</sup> July). It might be due to period coincide with high humidity and warm weather with frequent rainfall. Out of fifty-one varieties evaluated, none of the variety was found resistant when canes were inoculated with CF 07 isolate. Whereas, six sugarcane varieties were found resistant when canes were inoculated with CF 08 isolate.

#### Keywords

Sugarcane, inoculation, evaluation, varieties, red rot, disease.

#### Article Info

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### Introduction

Sugarcane grown in over 110 countries and about 50 per cent of world sugarcane production occurs in Brazil and India (FAO 2016). Sugar industry is the second largest agro processing industry in the country with significant contribution to the income,

employment and tax revenue of the rural area (Priya *et al.*, 2015). Sugarcane is cultivated in an area of 4.44 mha in India with the annual production of 306.07 lakh tonnes and cane productivity of around 69.0 t/ha with an average sugar recovery of approximately 10%. In Bihar, it has occupied an area of 0.24 mha with a production of 13.04 t/ha. with an

average productivity of 54.42 t/ha (ISMA, 2019). Among the various diseases affecting sugarcane, the red rot disease caused by *Colletotrichum falcatum* (Went.) is a major constraint for sugarcane production. The disease causes direct losses in terms of reduction in yield and juice quality as well as indirect losses by imposing a severe limitation on cultivation of various high sugar, high yielding genotypes which often fall susceptible to red rot (Duttamajumder, 2008).

Losses due to red rot may range from 10-50 % depending upon the cultivars, environment and pathogen strain (Ghazanfar and Kamran, 2016). This dual loss of juice content and quality results in great losses for the sugarcane growers as well as sugar mill. Among the different management practices, planting of resistant varieties is the best way to overcome the problem. However, due to the emergence of new pathotypes of this fungus, the newly released resistant varieties of them becomes susceptible after some periods of cultivation and makes breeding of resistant variety is an important routine process for effective control of disease.

Therefore, continuous efforts are being made to find out the suitable period for artificial inoculation and resistant genotypes which can be utilized by the breeder in evolving resistant varieties against red rot disease by using plug and cotton swab methods of inoculation against red rot disease of sugarcane.

### **Materials and Methods**

To find out the suitable time for inoculation, an experiment was conducted at Sugarcane Research Institute farm Pusa, on different dates of inoculation on the development of red rot disease of sugarcane. The experiment was planted in RBD factorial design with three replications having plot size of 5.0×2.7 m<sup>2</sup> in which, three sugarcane susceptible

varieties to red rot disease (CoSe 95422, CoSe 92423 and CoS 8436) were planted with 90 cm row to row distance in five rows. One ml inoculum was inoculated by plug method in ten canes in first, second, third and fourth row on ten days interval in each date of inoculation (26<sup>th</sup> July, 5<sup>th</sup> August, 15<sup>th</sup> August and 25<sup>th</sup> August) 2018, respectively, whereas, the fifth row was kept as check.

### **Treatment**

- T<sub>1</sub> – Inoculation on 26<sup>th</sup> July, 2018
- T<sub>2</sub> – Inoculation on 5<sup>th</sup> August, 2018
- T<sub>3</sub> – Inoculation on 15<sup>th</sup> August, 2018
- T<sub>4</sub> – Inoculation on 25<sup>th</sup> August, 2018
- T<sub>5</sub> – Check (no inoculation)

Observations on disease development were carried out after 60 days of inoculation in each treatment. For the observation on disease development the inoculated plants in different treatments were cut, split opened and examined on the basis of condition of tops, lesion width, white spots and nodal transgressions scored and rating were given according to the international scale (0-9) (Srinivasan and Bhat 1961; Kalaimani, 2000).

Scale	Rating
0.0 - 2.0	Resistant
2.1 - 4.0	Moderately resistant
4.1 - 6.0	Moderately susceptible
6.1 - 8.0	Susceptible
Above 8.0	Highly susceptible

To find out the level of resistance in sugarcane varieties, a field trial was also conducted at Sugarcane Research Institute farm, Pusa (Bihar). Three budded sets of 50 varieties having one check (CoSe 95422) were planted in three rows of 5-meter-long in the second week of February and normal

agronomical practices were followed. 10 canes of each variety were artificially inoculated by plug and cotton swab methods of inoculation in the 3<sup>rd</sup> week of August with isolates of CF 07 and CF 08. In case of plug method, inoculation was done in the middle of 3<sup>rd</sup> exposed internodes from the bottom. Holes were made with the help of inoculators and inoculum was injected in the hole and sealed immediately with wax coated papers. After 60 days of inoculation, canes were split opened longitudinally as scored as per the international scale (0-9), (Shrinivasan and Bhat, 1961; Kalaimani, 2000). The observations were made on the basis of condition of top, nodal transgression, lesion width and nature of white spots. The value of all the symptoms is added and the score on 0-9 scale is arrived as follows.

### **Condition of top**

Green (0), yellow / dry - 1

### **Lesion width above inoculated internodes were assigned the score**

If one third of cane width was affected - 1

Two third of cane width was affected - 2

Whole width of cane was affected - 3

### **White Spot**

White spot restricted - 1

White spot progressive - 2

### **Nodal Transgression**

If one node crossed - 1

If two node crossed - 2

If three or more than three nodes crossed - 3

In case of cotton swab method of inoculation, leaf sheath of ten canes (top most green) were removed and immediately placed cotton swab dipped in red rot pathogen suspension around

of the exposed nodes. Thereafter, nodes were tightly covered and wrapped with wax coated paper to maintain high humidity at nodes. After 60 days inoculated nodes are scrapped with knife. The varieties with reddish lesions/spots appearing or spreading were rated as susceptible and varieties with no lesions/no spots development are rated as resistant.

## **Results and Discussion**

The result of the impact of date of inoculation through artificial inoculation against red rot disease of sugarcane clearly indicated that there was a considerable difference in infection level varied upon these three cane cultivars. The experiment was conducted on the extent of different time of inoculation on the severity of red rot disease of sugarcane and data so obtained are presented in Table 1. In all the three varieties, the different dates of inoculation showed significant differences in each infection part based on the total score.

The data indicate that maximum infection (8.4, 8.2 and 7.8,) were recorded in all the three varieties CoSe 95422, CoS 8436 and CoSe 92423 respectively, when the canes were inoculated on 25<sup>th</sup> August followed by 15<sup>th</sup> August, 5<sup>th</sup> August and 26<sup>th</sup> July inoculated canes as compared to control (4.5,4.3and 4.1) respectively.

In case of variety CoSe 95422 the minimum infection (5.2) was observed when the canes were inoculated on 26<sup>th</sup> July followed by 6.2, 6.6 and the maximum (8.4) when the cane were inoculated on 5<sup>th</sup> August, 15<sup>th</sup> August and 25<sup>th</sup> August respectively and they were graded as moderately susceptible to highly susceptible reaction. In case of variety CoS 8436 the minimum infection (5.2) was recorded when the canes were inoculated on 26<sup>th</sup> July followed by 5.8, 6.3 and the maximum (8.2) when the canes were

inoculated on 5<sup>th</sup> August, 15 August and 25<sup>th</sup> August respectively, and they were graded as moderately susceptible to highly susceptible reaction. Whereas, in case of variety CoSe 92423 the minimum infection (5.0) was observed when the canes were inoculated on 26<sup>th</sup> July followed by 5.6, 6.2 and the maximum (7.8) when the canes were inoculated on 5<sup>th</sup> August, 15 August and 25<sup>th</sup> August respectively and they were graded as moderately susceptible to susceptible reaction against red rot disease.

Thus, the data presented in (Table 1) revealed that maximum disease infection exhibited when the canes were inoculated on 25<sup>th</sup> August followed by 15<sup>th</sup> August 5<sup>th</sup> August and minimum on 26<sup>th</sup> July respectively and graded as moderately susceptible to highly susceptible as compared to control (4.5, 4.3 and 4.1) in all the three tested varieties (CoSe 95422, CoSe 92423 and CoS 8436) against the red rot disease.

The severity of red rot disease was maximum when canes were inoculated during August month (25<sup>th</sup> August), it might be due to period coincide with relative humidity and warm weather.

Red rot disease is responsible for quick decline of commercial varieties and it is mainly due to the development of new pathotypes in red rot flora or another reasons. The use of resistant varieties is the cheapest and reliable method of disease control to avoid any epidemics. Development of new varieties is the needs of the time to give boost a sugar mills and farmers in Bihar as well as nation.

The data in (Table 2) revealed that 51 (fifty-one) varieties including one check were evaluated artificially by plug and cotton swab methods of inoculation by *Colletotrichum falcatum* pathogen with CF 07 and CF 08

isolates. In plug method of inoculation four varieties (CoSe 14454, CoSe 15453, CoSe 92423 and CoBln 14502) were observed susceptible, eight varieties (CoLk 15466, CoSe 15452, CoSe 15456, CoLk 14206, CoBln 15502, CoLk 15468, CoLk 14208, and CoLk 14207) were found moderately susceptible whereas, rest thirty-eight varieties were observed moderately resistant against CF 07 isolate.

While, six varieties namely (CoLk 15467, CoP 14437, CoP 14438, CoP 06436, CoP 2061 and CoP 13439) were found resistant whereas, seven varieties (CoLk 15466, CoSe 15452, CoSe 15456 CoBln 15502, CoLk 15468, CoLk 14208 and CoLk 14207) were found moderately susceptible and five varieties (CoLk 14206, CoSe 14454, CoSe 15453, CoSe 92423 and CoBln 14502) were observed susceptible while, remaining 32 varieties were observed moderately resistant reaction against CF 08 isolate against red rot disease.

Whereas, in cotton swab method of inoculation, four varieties (CoLk 14206, CoSe 14454, CoSe 92423 and CoBln 14502) showed susceptible reaction against both the tested isolates, while forty-six varieties were observed resistant against both the tested isolates, (CF 07 and CF 08) against red rot disease.

It is clear from the data (Table 2) that both methods of inoculation showed significant difference among each infection part based on the total score given. More susceptible reaction were observed in case of plug method of inoculation hence, plug method of inoculation is more reliable method of inoculation than cotton swab method of inoculation and this method should be followed while screening of varieties under artificial inoculation against red rot in field condition is concerned.

**Table.1** Effect of different dates of inoculation on the development of red rot disease

Varieties	CoSe 95422						CoS 8436						CoSe 92423					
	CT	LW	WS	NT	Total	Reaction	CT	CW	WS	NT	Total	Reaction	CT	CW	WS	NT	Total	Reaction
<b>1<sup>st</sup> (26<sup>th</sup> July)</b>	0.6	1.4	1.4	1.8	5.2	MS	0.7	1.5	1.4	1.6	5.2	MS	0.7	1.4	1.3	1.6	5.0	MS
<b>2<sup>nd</sup> (5<sup>th</sup> August)</b>	1.0	1.6	1.6	2.0	6.2	S	0.9	1.5	1.5	1.9	5.8	MS	0.9	1.4	1.4	1.9	5.6	MS
<b>3<sup>rd</sup> (15<sup>th</sup> August)</b>	1.0	1.8	1.6	2.2	6.6	S	0.9	1.8	1.5	2.2	6.3	S	0.9	1.7	1.5	2.1	6.2	S
<b>4<sup>th</sup> (25<sup>th</sup> August)</b>	1.0	2.9	1.7	2.8	8.4	HS	1.0	2.8	1.6	2.8	8.2	HS	1.0	2.4	1.8	2.6	7.8	S
<b>Control (Without Inoculation)</b>	0.5	1.2	1.3	1.5	4.5	MS	0.6	1.2	1.3	1.2	4.3	MS	0.5	1.2	1.0	1.4	4.1	MS
<b>CV %</b>	8.08	9.01	7.63	7.83	-	-	7.89	6.80	6.55	7.14	-	-	8.07	7.03	6.90	7.17	-	-
<b>CD (0.05)</b>	0.09	0.19	0.08	0.29	-	-	0.09	0.22	0.08	0.26	-	-	0.13	0.22	0.19	0.26	-	-
<b>Sem ±</b>	0.03	0.06	0.03	0.09	-	-	0.03	0.06	0.02	0.08	-	-	0.04	0.07	0.05	0.06	-	-

\*\* CT (Condition of top = 1), LW (Lesion Width = 1 - 3), WS (White spot = 1 - 2), NT (Nodal Transgression = 1 - 3)

**Table.2** Screening of sugarcane varieties against red rot disease

S.N.	Varieties	Plug Method				Cotton Swab	
		CF 07		CF08		CF 07	CF 08
		Reaction	Rating	Reaction	Rating	Rating	Rating
1	CoBln 15501	3.2	MR	2.6	MR	R	R
2	CoLk 15466	5.2	MS	4.4	MS	R	R
3	CoLk 15467	3.0	MR	1.6	R	R	R
4	CoP 15436	3.2	MR	3.4	MR	R	R
5	CoP 15437	2.6	MR	2.2	MR	R	R
6	CoSe 15451	3.4	MR	2.6	MR	R	R
7	CoSe 15452	5.2	MS	4.4	MS	R	R
8	CoSe 15455	2.4	MR	2.2	MR	R	R
9	CoSe 15456	5.2	MS	4.6	MS	R	R
10	CoLk 14206	5.1	MS	6.2	S	S	S
11	CoP 14437	2.6	MR	1.2	R	R	R
12	CoSe 14451	3.0	MR	3.2	MR	R	R
13	CoSe 14454	6.4	S	6.2	S	S	S
14	CoP 13437	2.4	MR	3.2	MR	R	R
15	CoSe 13451	2.8	MR	2.2	MR	R	R
16	CoSe 13452	3.0	MR	2.6	MR	R	R
17	CoBln 15502	4.6	MS	4.4	MS	R	R
18	CoLk 15468	4.8	MS	4.8	MS	R	R
19	CoLk 15469	2.8	MR	3.2	MR	R	R
20	CoP 15438	3.1	MR	2.6	MR	R	R
21	CoP 15439	3.4	MR	2.8	MR	R	R
22	CoP 15440	2.2	MR	3.4	MR	R	R
23	<b>CoP 15441</b>	<b>3.6</b>	<b>MR</b>	<b>2.4</b>	<b>MR</b>	<b>R</b>	<b>R</b>
24	CoSe 15453	6.6	S	6.2	S	R	R
25	CoSe 15454	3.0	MR	3.4	MR	R	R
26	CoSe 15457	2.6	MR	2.4	MR	R	R
27	CoLK 14208	5.2	MS	4.6	MS	R	R
28	CoLk 14209	2.2	MR	2.6	MR	R	R
29	CoP 14438	2.4	MR	1.2	R	R	R
30	CoP 14439	2.2	MR	3.0	MR	R	R
31	CoSe 14455	3.0	MR	3.2	MR	R	R
32	BO 91	3.6	MR	3.2	MR	R	R
33	CoP 06436	3.2	MR	1.0	R	R	R
34	CoP 9301	3.4	MR	3.2	MR	R	R
35	CoLk 94184	3.6	MR	3.2	MR	R	R
36	CoSe 01421	2.2	MR	3.6	MR	R	R
37	CoLk 14210	3.2	MR	3.0	MR	R	R
38	CoP 14436	3.6	MR	3.2	MR	R	R



39	CoSe 14456	2.8	MR	3.2	MR	R	R
40	BO 155	2.2	MR	2.4	MR	R	R
41	CoSe 92423	6.2	S	6.4	S	S	S
42	BO 130	2.4	MR	2.8	MR	R	R
43	CoLk 09204	3.0	MR	3.4	MR	R	R
44	CoLK 14207	4.8	MS	5.2	MS	R	R
45	CoP 14452	2.6	MR	3.0	MR	R	R
46	CoP 2061	2.2	MR	1.6	R	R	R
47	CoSe 14453	3.4	MR	3.6	MR	R	R
48	CoBln 14502	6.4	S	7.0	S	S	S
49	CoP 13438	2.6	MR	2.8	MR	R	R
50	CoP 13439	2.2	MR	1.2	R	R	R
51	CoSe 95422 (Check)	6.4	S	6.8	S	S	S

R – Resistance, MR - Moderately Resistant, MS - Moderately Susceptible, S - Susceptible, HS - Highly Susceptible



1<sup>st</sup> (26<sup>th</sup> July)



2<sup>nd</sup> (5<sup>th</sup> August)



3<sup>rd</sup> (15<sup>th</sup> August)



4<sup>th</sup> (25<sup>th</sup> August)

**Fig.1** Views of splitted canes on different dates of inoculation

Maximum disease development was observed when the canes were inoculated on 25th August. It might be due to coincide with congenial weather viz., warm weather with high humidity having frequent rains.

Though, the development of red rot pathogen was observed more during 2<sup>nd</sup> and last week of August, on that basis it may be the suitable period for artificial inoculation in sugarcane crop in Bihar Agro-ecosystem. Plug method of inoculation was found more reliable than cotton swab method of inoculation for evaluating the varieties against red rot disease of sugarcane.

The evaluation of varieties for their reaction will help in minimizing the outbreak of the disease. The variety having resistance to moderately resistant reaction with good agronomical attributes can be a good source for evolving varieties in breeding programme

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